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# MONTHLY WEATHER REVIEW

## JULY 1937

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WEATHER BUREAU

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## CORRECTION

Volume 65, May 1937, page 196; the 3rd paragraph should read: "Dr. Brooks computed, from the tests made with the National Bureau of Standards' screens and Feussner's transmissions in infra-red, the transmission of the yellow screen to be 0.868, and that of the red screen to be 0.815." In the same REVIEW, page 199, the date at the top of the left-hand side of the page in "LATE REPORT" should be "March" instead of "Nov."

Volume 65, June 1937, page 234, foot of 2d column, in the left member of the equation insert "$\sigma$" in front of "$\lambda\nu^4$". In the same issue, page 252, table 1, *South Atlantic States*, the average cloudiness "5.6" should be "5.8".

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# MONTHLY WEATHER REVIEW

Editor, EDGAR W. WOOLARD

VOL. 65, No. 7
W. B. No. 1214

JULY 1937

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## THE GREENHOUSE EFFECT OF VOLCANIC DUST

By W. J. HUMPHREYS

A dense, dry fog, persistent and all-prevailing, made the European summer of 1783 forever memorable in meteorological literature and tradition. Among the most interesting of the numerous recorded comments about it are those of Franklin who, in May 1784, wrote as follows:

> During several of the summer months of the year 1783, when the effects of the sun's rays to heat the earth in these northern regions should have been the greatest, there existed a constant fog over all Europe, and great part of North America. This fog was of a permanent nature; it was dry, and the rays of the sun seemed to have little effect toward dissipating it, as they easily do a moist fog arising from the water. They were indeed rendered so faint in passing through it that, when collected in the focus of a burning-glass, they would scarce kindle brown paper. Of course, their summer effect in heating the earth was exceedingly diminished.
>
> Hence the surface was early frozen.
>
> Hence the first snows remained on it unmelted, and received continual additions.
>
> Hence perhaps the winter of 1783–4 was more severe than any that happened for many years.
>
> The cause of this universal fog is not yet ascertained. Whether it was adventitious to this earth, and merely a smoke proceeding from the consumption by fire of some of those great burning balls or globes which we happen to meet within our course round the sun, and which are sometimes seen to kindle and be destroyed in passing our atmosphere, and whose smoke might be attracted and retained by our earth; or whether it was the vast quantity of smoke, long continuing to issue during the summer from Hecla, in Iceland, and that other volcano which arose out of the sea near that island, which smoke might be spread by various winds over the northern part of the world, is yet uncertain.
>
> It seems, however, worthy the inquiry, whether other hard winters, recorded in history, were preceded by similar permanent and widely-extended summer fogs. Because, if found to be so, men might from such fogs conjecture the probability of a succeeding hard winter, and of the damage to be expected by the breaking up of frozen rivers in the spring; and take such measures as are possible and practicable to secure themselves and effects from the mischiefs that attend the last.[1]

From these remarks it appears that Franklin suspected that this dry fog might be volcanic dust from Iceland. This supposition seems to be fully confirmed by the fact that Skaptar Jökull exploded violently on June 8 of that year, and again on June 18.

Franklin seems further to infer, and naturally because of the enfeebled insolation, that in Europe, where dry fog prevailed, the summer of 1783 was abnormally cool. On the contrary, however, as pointed out by E. L. Hawke,[2] this summer was very abnormally warm in western and northern Europe. And the reason therefor, or at least what appears to be a sufficient reason, is the greenhouse effect of relatively coarse volcanic dust (probably flaky rock fragments, broader than thick and floating flatwise). Such material is a much better absorber of the long-wavelength earth radiation than it is of the much shorter wavelength solar radiation,[3] and therefore, so far as absorption alone is concerned, must produce a direct greenhouse effect. Turning now to symbols for simplicity and brevity, let $I$ be the 24-hour average intensity (energy flow per square centimeter per minute) of the normal component of the incoming sunshine, and $a$ the fraction of this component absorbed by the dust; and let $E$ be the 24-hour average intensity of the vertical component of the radiation, chiefly terrestrial, but a little reflected solar, just beneath the dust, and $b$ the fraction of this mixed component absorbed by the dust. Clearly, of each of the two quantities of energy, $aI$ and $bE$, absorbed by the dust one-half goes outward and one-half inward, partly, in each case through direct reradiation by the dust and partly through radiation by the air warmed by the heated dust.

Obviously, when equilibrium is reached the amount of the inner radiation, $E$, that directly and indirectly gets *out* through the dust layer is exactly equal to the amount of the outer radiation, $I$, that gets *in* through this layer, otherwise the earth would be growing progressively colder or steadily warmer over and above the normal seasonal changes. Therefore

$$E-\frac{b}{2}E=I-\frac{a}{2}I$$

or

$$E=I\frac{2-a}{2-b}$$

When there is no dust, or when $a$ and $b$ each is zero, or equal to each other whatever their value,

$$E=I.$$

But when dust is present and of the kind for which $b$ is greater than $a$, $E$ is greater than $I$, and the surface temperature is increased.

Let, for example, the absolute temperature of the radiating virtual under surface be 300° A. when there is no dust, then in the presence of a dust layer covering 10 percent of the sky everywhere, and for which $a=\frac{1}{4}$, and $b=\frac{1}{2}$, the absolute temperature, $T$, of this under surface may be computed as follows, assuming that the intensity of the radiation varies directly as the fourth power of the absolute temperature of the radiating surface, which it does, roughly, for most substances:

$$T^4=300^4\left(\frac{9}{10}+\frac{1}{10}\,\frac{2-\frac{1}{4}}{2-\frac{1}{2}}\right)=(303.68)^4$$

and

$$T=303.68°\text{A},$$

an increase of 3.68° C. owing to the dust. If but 5 percent of the sky were covered the increase of temperature would be 1.86° C. If the sky were completely covered by this dust—no interstices through which radiation might dodge the dust—the temperature increase would be 32° C.

[1] Sparks, "Life of Benjamin Franklin", 6: 455–457.
[2] Q. Jr. Ry. Meteorol. Socy., 63, 456, 1937.
[3] Coblentz, Publications of Carnegie Institution of Washington, Nos. 65 and 67.

If, again, $a=\frac{1}{4}$ and $b=\frac{3}{4}$, with the other conditions as above, the several temperature increases would be 2.95° C., 1.49° C., and 26.32° C., respectively.

Apparently, therefore, it is logical enough to attribute the abnormally high temperatures of western and northern Europe of June–August 1783 to the direct greenhouse effect of the relatively coarse volcanic dust from Icelandic volcanoes, Skaptar Jökull especially.

Franklin further states, in the quotation above, not as a surmise, but as an observed fact, that the winter of 1783–84 was abnormally cold. So it was, and so were the 3 years 1784–86 inclusive.[4] However, this widespread low temperature, covering North America, Europe, and northern Asia, or all places where instrumental observations were taken, and presumably, therefore, world-wide, hardly could have been caused by the dust from Skaptar Jökull, or, at any rate, not by its coarser portions, but most likely chiefly, if not well-nigh wholly, by the much higher and far finer dust from Asama in Japan, which exploded violently on August 2, 1783, and more violently still on August 5, 1783. Dust of this sort and size that in appreciable amounts may remain in the stratosphere even 2, 3, or, possibly, 4 years, depletes passing radiation essentially by diffraction, or scattering, and not mainly by absorption, as do relatively large particles. The theory of this inverse greenhouse effect of fine volcanic dust [5] will not be repeated here as it is rather long and tedious. It shows that the fine dust in question shuts out solar radiation far more effectively than it shuts in earth radiation and therefore causes a greater or less decrease of surface temperatures.

Presumably, then, the summer of 1783 was rendered abnormally warm in western and northern Europe by the then prevailing pall in that region of relatively coarse volcanic dust from Skaptar Jökull, especially; and the following 3 years abnormally cold over much, if not all, of the world by the high, fine dust from Asama.

And it comes to this: Volcanoes, like the man in the fable, can blow hot and blow cold with the same breath, but that shall not provoke us to wrath.

[4] W. Köppen, Zeit, Ost. Gesel. für Meteorol. 8, 260, 1873.

[5] Physics of the Air, McGraw-Hill Book Co., 1929.

## SHIELDED STORAGE PRECIPITATION GAGES [1]

By J. CECIL ALTER

[Weather Bureau, Salt Lake City, Utah, June 1937]

The gist of nearly two centuries of precipitation gage literature is, that a precipitation gage in any location freely exposed to the upper arch of the sky, will collect a perfect sample of either rain or snow when the air is calm or is moving with only light to moderate velocity, such as are the conditions when much, if not most, of the precipitation occurs.

In the path of a strong wind, however, the precipitation gage, like any other isolated object or structure, becomes a disturbing obstacle, around which, and over the top of which, the immediately adjacent air passes with increased speed. Thus in strong winds the fabric of falling snow is expanded over the gage where the wind runs fastest and the snow pattern is condensed in a spot immediately to the lee of the gage where the wind slows up. As a result, a deficiency of snow is deposited over the gage, and an equal excess is deposited in a similar area a few feet to the leeward. That is to say: During strong winds a small but variable part of the snow rightfully belonging to the gage misses the gage.

The distortion of the sample thus taken, or the deficit in the catch, increases with increased wind velocity; and is from two to four times greater for snow than for rain. The well-known decrease in the catch with increase in elevation of the precipitation gage above ground, results chiefly, it is usually conceded, from the increase in wind velocity in the loftier positions.

For the usual ground exposures where probably 95 percent of the Weather Bureau gages are exposed, the shrubbery, fences, orchards, shade trees, buildings, and other objects rising on the horizon of the precipitation gage tend to slow up and equalize the speed of the wind over the gage (decrease the range between minimum and maximum velocity). This consequently increases the catch of moisture, and substantially decreases the variability of the catch.

Skyscraper roof exposures so often deprecated as precipitation gage sites are not all bad, for the building itself is often ideally fitted with an overhanging ornamental cornice which substantially prevents the wind stream from rising and racing at increased speed across the roof. On such a shielded roof a precipitation gage may be placed fairly near the edge, or in any areaway available with reasonable safety to the catch, for the building itself constitutes a huge, shielded precipitation gage.

The user of precipitation data may rest assured, however, that these general defects may nearly all be considered of a minor order or character; because the data, after all, bear a pretty constant ratio to the general precipitation over an area of a few hundred square miles nearest the gage. Thus most precipitation data, despite their well-known defects, are a factor of comparatively dependable constancy among such related variables as evaporation, transpiration, surface run-off, and soil absorption, in hydrologic formulas.

No considerable number of Weather Bureau gages in use are exposed to the full sweep of the wind from any direction, since they are nearly always placed in convenient but sequestered positions on farmsteads or home premises where a certain amount of needful sheltering is always present. Nevertheless, there are usually a few gages in important sections of every State which have inadequate windbreaks, at least in certain quadrants of the gage horizon, and therefore leave the precipitation gage unduly exposed to the certain winds.

Probably a still larger number of gage exposures could be improved if some simple, uniform system of shielding were available, to reduce the variability of the catch in the differing exposures of neighboring gages, and for different velocities and directions of wind over the same gage; that is, if a trustworthy, artificial windbreak could be attached to the gage to give all exposures a semblance of uniform wind eddy control.

A new need for dependable snow gages exists in the unpopulated mountain areas of the West, where there is no one to make daily observations. In these cases the gage must not only effect a reliable collection of perfect samples or falls of snow and rain, in calms as well as in strong winds, but it must preserve this moisture until the gage can be visited and the contents measured (say at the end of the month, since all Weather Bureau data are published in monthly units). Wherever there is a need for a snow survey course, there is a need for at least one sea-

[1] Delivered before the American Meteorological Society at Denver, Colo., June 22, 1937.

FIGURE 1.—Looking southeast, across the experimental plat at Terminal Station, 7 miles west of Salt Lake City, 1936. Four gages with cloth shields in the distance and three with metal-leaf shields in the foreground. No. 1 unshielded check gage is at the extreme left; unshielded check gage no. 9 is just out of view at the extreme right.

FIGURE 2.—Looking northeast. Gage no. 8 in the foreground.

sonal precipitation gage: while an equal or even greater number of such gages are needed on the unpopulated plains areas of the West, for use in studies of forage production, soil erosion, and so forth.

The air that passes with increased speed around the precipitation gage only blows away the snow from the sides of the gage, and does not affect the catch. Thus the thing to be desired, and apparently the only thing that can be done, is to prevent the compression of the air against the gage and the rush of air over the top of the gage by deflecting it downward and away from the receiver or gage mouth. This will leave an unaffected, undistorted movement of air over the top of the gage, comparable to the air movement over the place if the gage were not there.

Nipher did this for rain gages at St. Louis in 1878. He used a trumpet-shaped shield made of sheet metal at the base and wire screen in the upper, wider part of the flare. Marvin designed a shielded snow gage 30 years ago that was nearly perfect for collecting snowfall during strong winds; and it was large enough to preserve several months moisture without emptying. In relatively quiet weather, however, when most snow falls, the wide shelf-like shields, which are set a little above the gage top, collect about as much snow as the gage. The snow, thus piled up on the shield, sometimes to a depth of a foot or more, may thus be blown into the gage receiver, or if solidified by freezing after a slight thaw may vitiate a subsequent catch because of the serious obstruction it offers to the gage receiver.

A common board fence, railing, or guard of almost any kind, placed a few feet from an ordinary gage and about level with the gage top, has been commended by experimentors for years, as tending to increase the amount of the catch and to improve the stability of the catch.

Storage precipitation gages, charged with salt to prevent freezing, and oil to prevent evaporation, have been used regularly with some success in Utah for the past 12 or 15 years. No really serious or unsolvable problem has resulted from the corrosion of gages, and there has apparently been no material loss of moisture due to evaporation, or to the failure of the snow to penetrate the oil film and melt promptly in the brine.

Salt water does not freeze in the ordinary sense of the word; but at low temperatures ice crystals and salt particles separate out, usually in a suspended mass, which does not have the expansive force of ice, does not adhere to the container, and does not float high enough to close the brine surface against further snow receipts. A pound of salt is enough to produce and maintain a high concentration of brine for an 8-inch gage, since the ice crystals always drop out first as the temperature falls. Larger gages need more salt.

Almost any good quality of light oil is satisfactory, though a first-class turbine oil safely undergoes a wide range of temperatures, will endure indefinitely on water without emulsifying or disintegrating, and remains a thin, penetrable film at most snowfall temperatures. About 4 ounces of oil makes a good film, and is sufficient to seal off the brine from the air—the chief source of gage corrosion.

When the 8-inch gage fills within a foot of the top, the contents may be partly or completely emptied as desired; salt is added in proportion, and 2 or 3 ounces of oil will replenish the loss. Measurements are best made by weighing, the gage being exposed without funnel or brass inner tube. A bracket on a portable staff supports the spring-balance scales over the gage, the gage can being lifted with a detachable bail inserted in drill holes at the rim.

Thirty years ago, April 16, 1907, the writer placed 0.20 inch of olive oil on 0.20 inch of water in an 8-inch precipitation gage overflow can covered with funnel receiver but without the inner measuring tube, beside the official 12-inch tipping bucket rain gage at the Salt Lake City Weather Bureau office. On November 3, 1907 the net contents of the storage gage was found to be 7.77 inches or 97 percent of the 8.03 inches that had been measured in the interval in the regular gage.[2] That total happens to be about half the normal annual precipitation at Salt Lake City.

As a result of the above experiment, in the summer of 1910, from April to October inclusive, 10 or 12 improvised storage precipitation gages, using oil films, were exposed by the Utah farmers, on instructions issued from the Salt Lake City office of the Weather Bureau by A. H. Thiessen, then section director. The results were rather gratifying as reported in the MONTHLY WEATHER REVIEW, December 1910, page 1885.

About that time the writer did some experimenting with cloth windshields, and with antifreeze solutions as well as with gages buried, covered, or housed to prevent freezing.[3]

Opportunity again came in the early 1920's for further experimenting, chiefly with salt to prevent freezing. By 1925 this project, developed at the Salt Lake City Weather Bureau office, seemed so practicable, that the three Marvin shielded gages (unmanned in winter) at Alpine, Oak Brush, and Headquarters substations of the Great Basin Forest Service Experiment Station in the mountains near Ephraim, Utah, were charged with brine and paraffin oil for monthly measurement of the increment. This was done with the cooperation of C. L. Forsling, experiment station director, and other Forest Service officials. The records at those stations have been continued, practically to date, with only a few months missing. All data for the 6 winter months for the 12 years past have been obtained by means of the storage gages, using salt and oil.

In 1935, under an allotment of funds by the Weather Bureau, through the River and Flood Division, some more extensive experiments were undertaken in shielding snow gages and storing precipitation. Twenty-seven small cans or containers were exposed on the Weather Bureau office roof at Salt Lake City, to try the resistence of the various metals and combination of metals, and paints and other coverings to the corrosive and galvanic action of salt. Also about as many gages in the field were similarly put on tests.

To date this particular experiment has yielded these apparently justified conclusions: That a copper gage heavily welded with copper welding rod at the folded seams down the side of the gage is practically invulnerable. The bottom seams can usually be covered with a depth of paint or asphaltum or other calking material. A copper fused seam (using no other metal) is too weak and readily develops leaks; stainless steel, Monel, and some other metals are too expensive and are vulnerable at a soldered seam. Even galvanized sheet iron and common tin cans with folded seams well soldered over are trustworthy for some time when oil is used on the brine. But seamless copper or glass gage cans are about the only ones likely to stand up indefinitely because of the galvanic or electrolytic action of the brine against two metals at a gage seam.

We also prepared and exposed about 25 gages fitted with a variety of shields. The principal experimental

[1] MONTHLY WEATHER REVIEW, November 1907, page 511.
[2] See Weather Bureau Circular E, Instrument Division, Measurement of precipitation by C. F. Marvin, 1910, reprinted in 1913, p. 29, also p. 34, par. 96, fig. 7 and par. 81.

plat is at the Utah Power & Light Co.'s Terminal Station, 7 miles west of Salt Lake City, on a wind-swept, water-leveled plain where the average annual precipitation is about 15 inches and snowfall about 50 inches. Most of the 20 gages in this group stand 3½ feet high and are from 25 to 35 feet apart in orderly arrangement. The gages are standard 8-inch cans, without funnels or inner tubes.

Two gages are 4 feet deep, one being 10.488 inches and the other 14.833 inches in diameter, in which an ounce of water represents 0.02 inch and 0.01 inch respectively. These wide-mouthed gages were provided to observe, if possible, the clinging of wet snow to the top of the gages which sometimes fouls a gage receiver. This difficulty, however, is appreciably lessened by the windshields, which diminish the force of the winds that drive the snow against the top of the gage. The shields also prevent wind eddies from carrying dry snow out of the gages to an appreciable extent.

Four gages are fitted with open skirts or shields made of 8-ounce khaki tenting canvas, cut into wedge-shaped leaves from a band at the top, the whole suspended on a substantial circular iron frame. The lower ends of the 12 pendent leaves, 16 inches long (21 inches on some gages) are strung together on a brass chain in a somewhat smaller circle than the top; and each leaf is stiffened with a single wire rib. The leaves are cut so that the openings between them close up when the leaves are blown in at an angle of about 45°.

Three gages are fitted with shields having diameters of 16, 24, and 34 inches and made of 20-gage galvanized sheet iron, cut into wedge-shaped leaves and suspended on an iron frame, identical with that supporting the canvas shields. These metal leaves are freely hinged on the heavy wire ring at the top and held apart by iron washers. They are connected at the bottom with a brass chain somewhat shorter than the supporting ring. The leaves close up when swung inward at an angle of about 45°. The metal leaves are from 7 to 11 inches in length, on the different sized shields.

Five gages were shielded with combination lath fencing, sawed in two lengthwise. These strips of fencing were hung loosely from a circular support of heavy wire, hooked onto posts set about the gages. The bottom of this swinging "fence" is from 16 to 22 inches above the ground and is flared inward at the bottom by kinking or shortening the lower strand of twisted wires. Being suspended at the top strand of wires 2 inches from the top of the lath, and held in place by small nails in each lath, the bottom of the fence is free to "give" or sway easily with the wind.

Gage no. 10, with a 34-inch lath shield has an extra layer of lath fencing, the lath coming between the original lath, practically closing the "basket" or shield. The other fence shields are from 7 to 12 feet in diameter and the lath from 18 to 24 inches in length, all standing from 1 to 3 inches above the gage tops and clearing the ground by 15 to 20 inches.

Gages number 15 to 18 were arranged to simulate a pit or ground surface exposure, wherein the gage top is flush with the ground level, the gage itself presenting no obstruction to the wind; but in this case we sought to avoid the devastating fault of snow that has fallen, blowing from the ground surface into the gage. That is, at these gages the intention was to arrange a bottom surface of the wind horizontal with the gage top, which would be a surface on which no snow could be deposited, and consequently from which no snow could be blown into the gage.

The tops of these gages are 18 inches high, being sunk 6 inches in the ground. At gage number 16, the smallest possible number of lath and other sticks are carefully spaced in concentric circles and placed so as to prevent any stream of wind from reaching the gage undiverted or undivided. The tops of these sticks are uniformly at a level with the gage top. At gage no. 17, the baffle frames are level with the top of the gage, a few extra baffles being placed to windward. The spaces between the baffle forms are successively wider, counting from the gage. At gage no. 18, the fewest possible number of posts support a 12-by-16-foot area of wire netting, 2-inch mesh, the surface of which is level with the gage top. A wire ring holds the edge of the cut-out 8 inches from the gage. A few additional baffle frames are placed to windward. Access to the gage is gained by hinging a section of the wire netting.

Eight-inch gages, 30 inches deep and mounted from 6 to 12 feet high, fitted with cloth shields like experimental gage no. 6 (34.4 inches diameter, 1 inch above the gage) were exposed at the mountain snowfall stations (beside the official gages) at Clear Creek, 8,300 feet elevation, Kimberly 8,250 feet elevation, and Silver Lake 8,700 feet elevation (half mile distant), and at Salt Lake City 4,300 feet elevation, on a post 6 feet above the instrument platform. An unshielded storage gage was exposed beside the official gage at Salt Lake City; and another unshielded gage at the Highline City Creek station, 5,300 feet elevation, beside the official gage, in a glade or opening among the trees, naturally well sheltered against the wind.

Snowfall observations for 9 months have been made during the past two winters of unusually heavy snow, the experimental gage measurements being divided into six periods or sets of measurements. In order to determine the relative performance of the 18 comparable gages on the experimental plat, the average catch of the full set of gages at each measurement period, was determined and called 100 percent.[4] The percentage relationship of each gage was then computed for comparison. At the end of the sixth or last measurement period in the series, a general summation of all measurements gave a grand average as 100 percent.

The six measurements for each gage separately were also combined and an average percentage relationship determined. Thus it was found that unshielded check gages, numbers one and nine, on opposite sides of the plat, averaged only 85 percent of the 18-gage mean. No. 1 varied from 75 to 99 percent, its mean deviation or variability being 8.2 percent, the worst offender in the lot. The baffled gages, simulating pit exposures, averaged 112.5 percent of the 18-gage series. This may represent more nearly the deposit that would have been made on the plat, had there been no gages to obstruct the wind. Gage no. 17, the middle one with baffles, varied from 105 to 129 percent of the group mean, its mean variability being 7.1 percent.

The three metal shielded gages averaged just 100 percent, the same as the full set of 18. No. 7, with a 24-inch shield, varied from 92 to 106 percent with a mean variability of 3.8 percent, almost exactly the same as no. 4, the smallest metal shield. The 4 cloth shielded gages averaged 95 percent of the 18-gage mean, no. 6 ranging

[4] This method of checking has its faults, but as explained by others, it is about the best system available (see MONTHLY WEATHER REVIEW, July 1915, p. 318. Notes on the effects of rain gage exposures at Berkeley, Calif., by W. G. Reed.)

from 88 to 102 percent, with a mean variability of 3.4 percent. This was the second best performer in point of stability, on the lot.

Four of the lath fence shielded gages averaged 105 percent of the 18-gage mean, the largest one (no. 14) showing the largest average variability of 6.5 percent, ranging from 95 to 120 percent. No. 10, with the double lath shield, had a mean variation of 5.8 percent, ranging from 94 percent to 113 percent. The next best lath shield performer was no. 13, 7½ feet in diameter, with a mean deviation of 5.3 percent, ranging from 95 to 118 percent. While the three gages with metal shields and two with canvas shields are very efficient and promising, an almost neglected "dark horse" wins the sweepstakes, viz, gage no. 11 with the lath-fence shields 34.4 inches in diameter. It had a consistent variability averaging only 1.1 percent, ranging from extremes of only 96 to 100 percent. That is just one-third the average deviation of the second-best gage, and is probably too good to be true for a long series; but as we find nothing wrong with the computation, we must, up to the present, award the first place to the cheapest and simplest of all shields.

We expect to put this shield to further, more severe tests, by changing its position in the set and by mounting it in certain outlandish positions beside official gages elsewhere. It will be given an iron frame mounting similar to that used with the cloth and metal shields, dispensing with the wooden posts that now support it.

The relative efficiency of the several gages on the terminal experimental plot is shown in the following table.

| Efficiency rank no. | Gage no. | Description of shield: Material | Description of shield: Diameter | Description of shield: Above gage | Average variability | Least catch | Greatest catch | Difference | Average percent of 18-gage mean |
|---|---|---|---|---|---|---|---|---|---|
| | | | *Inches* | *Inches* | *Percent* | *Percent* | *Percent* | | |
| 1 | 11 | Lath fence | 34.4 | 1 | 1.1 | 96 | 100 | 4 | 98.8 |
| 2 | 6 | Canvas | 34.4 | 1 | 3.4 | 88 | 102 | 14 | 96.7 |
| 3 | 4 | Galvanized iron | 16 | ½ | 3.7 | 93 | 102 | 9 | 99.3 |
| 4 | 3 | Canvas | 40 | 6 | 3.7 | 85 | 95 | 10 | 91.0 |
| 5 | 7 | Galvanized iron | 24 | ¾ | 3.8 | 92 | 106 | 14 | 98.2 |
| 6 | 8 | do | 34.4 | 1 | 4.2 | 94 | 108 | 14 | 101.2 |
| 7 | 16 | Ground baffle | 75 | 0 | 4.7 | 106 | 119 | 13 | 111.6 |
| 8 | 5 | Canvas | 32 | 3¼ | 4.8 | 87 | 106 | 19 | 95.8 |
| 9 | 2 | do | 32 | 6 | 4.9 | 88 | 101 | 13 | 95.3 |
| 10 | 9 | None | | | 5.1 | 79 | 97 | 18 | 85.3 |
| 11 | 15 | None | | | 5.2 | 93 | 108 | 15 | 98.0 |
| 12 | 13 | Lath fence | 92 | 2½ | 5.3 | 95 | 118 | 13 | 105.0 |
| 13 | 10 | do | 34.4 | 1 | 5.8 | 94 | 113 | 19 | 105.2 |
| 14 | 12 | do | 56 | 1½ | 6.0 | 93 | 115 | 22 | 104.3 |
| 15 | 18 | Netting | 100 | 0 | 6.1 | 106 | 122 | 16 | 112.4 |
| 16 | 14 | Lath fence | 152 | 4½ | 6.5 | 96 | 120 | 24 | 105.5 |
| 17 | 17 | Ground baffle | 84 | 0 | 7.1 | 105 | 129 | 24 | 113.6 |
| 18 | 1 | None | | | 8.2 | 75 | 99 | 24 | 84.5 |

**EXPERIMENTAL STORAGE SNOW GAGE MEASUREMENTS**

[Grand totals, in inches, to May 31, 1937]

| Station | Official gage measurement | Storage gage measurement | Percent of official gage |
|---|---|---|---|
| | | | *Percent* |
| High line C. C | 28.22 | 29.40 (no shield) | 104 |
| Silver Lake | 63.38 | 55.98 (half mile distant) | 88 |
| Clear Creek | 26.51 | 23.90 (sheltered site) | 90 |
| Kimberly | 28.81 | 31.01 (windy site) | 108 |
| Salt Lake City | 28.83 | 31.46 (lower); 27.77 (higher) | 109<br>96 |

**EXPERIMENTAL SHIELDED STORAGE SNOW GAGES AT TERMINAL 7 MILES WEST OF SALT LAKE CITY**

UNSHIELDED CHECK GAGES

| Gage nos. | Shields: Diameter | Shields: Height | December 1935 | Percent | January 1936 | Percent | February 1936 | Percent | Oct. 28 and Dec. 1, 1936 | Percent | Dec. 1, 1936, and Mar. 27, 1937 | Percent | Mar. 27, and May 1, 1937 | Percent | Average variation percent | Percent of group average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Inches* | *Inches* | | | | | | | | | | | | | | |
| 1 | | | 0.70 | 89 | 1.63 | 75 | 1.25 | 76 | 1.24 | 78 | 4.93 | 90 | 1.29 | 99 | 8.2 | 84.5 |
| 9 | | | .66 | 84 | 1.73 | 79 | 1.38 | 84 | 1.25 | 79 | 4.86 | 89 | 1.26 | 97 | 5.1 | 85.3 |

CANVAS SHIELDS

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 32 | 6 | 0.77 | 97 | 1.92 | 88 | 1.66 | 101 | | | | | | | 4.9 | 95.3 |
| 3 | 40 | 6 | .74 | 94 | 1.86 | 85 | 1.55 | 95 | 1.37 | 86 | 4.97 | 91 | 1.24 | 95 | 3.7 | 91.0 |
| 5 | 32 | 3½ | .79 | 100 | 2.05 | 94 | 1.74 | 106 | 1.39 | 87 | 5.07 | 93 | 1.24 | 95 | 4.8 | 95.8 |
| 6 | 34.4 | 1 | .81 | 102 | 2.08 | 95 | 1.62 | 99 | 1.40 | 88 | 5.36 | 98 | 1.27 | 98 | 3.4 | 96.7 |

METAL SHIELDS

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 16 | ½ | 0.81 | 102 | 2.08 | 95 | 1.73 | 106 | 1.48 | 93 | 5.53 | 101 | 1.29 | 99 | 3.7 | 99.3 |
| 7 | 24 | ¾ | .80 | 101 | 2.05 | 94 | 1.74 | 106 | 1.47 | 92 | 5.30 | 97 | 1.29 | 99 | 3.8 | 98.2 |
| 8 | 34.4 | 1 | .83 | 105 | 2.14 | 98 | 1.77 | 108 | 1.49 | 94 | 5.64 | 103 | 1.29 | 99 | 4.2 | 101.2 |

LATH FENCE SHIELDS

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 34.4 | 1 | 0.84 | 106 | 2.47 | 113 | 1.86 | 113 | 1.50 | 94 | 5.79 | 106 | 1.29 | 99 | 5.8 | 105.2 |
| 11 | 34.4 | 1 | .79 | 100 | 2.16 | 99 | 1.64 | 100 | 1.53 | 96 | 5.46 | 100 | 1.28 | 98 | 1.1 | 98.8 |
| 12 | 56 | 1½ | .78 | 99 | 2.24 | 103 | 1.53 | 93 | 1.83 | 115 | 5.98 | 110 | 1.38 | 106 | 6.0 | 104.3 |
| 13 | 92 | 2½ | .79 | 100 | 2.27 | 104 | 1.55 | 95 | 1.87 | 118 | 5.88 | 109 | 1.36 | 105 | 5.3 | 105.0 |
| 14 | 152 | 4½ | .78 | 100 | 2.34 | 107 | 1.58 | 96 | 1.91 | 120 | 5.96 | 109 | 1.31 | 101 | 6.5 | 105.5 |

GROUND BAFFLES

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | Check gage | | 0.74 | 94 | 2.06 | 94 | 1.52 | 93 | 1.72 | 108 | | | 1.31 | 101 | 5.2 | 98.0 |
| 16 | Baffles | | .85 | 108 | 2.59 | 119 | 1.78 | 109 | 1.84 | 116 | | | 1.38 | 106 | 4.7 | 111.6 |
| 17 | do | | .85 | 108 | 2.81 | 129 | 1.80 | 110 | 1.85 | 116 | | | 1.36 | 105 | 7.1 | 113.6 |
| 18 | Netting | | .86 | 109 | 2.67 | 122 | 1.75 | 107 | 1.88 | 118 | | | 1.38 | 106 | 6.1 | 112.4 |
| | Average variability | | | 4.7 | | 11.2 | | 7.5 | | 12.2 | | 6.1 | | 3.2 | | |
| 19 | Gage diameter 10.488 inches | | | | | | | | | | 5.64 | 103 | 1.24 | 95 | | |
| 20 | Gage diameter 14.833 inches | | | | | | | | | | | | 6.82 | | | |
| | Means | | .79 | | 2.18 | | 1.64 | | 1.59 | | 5.46 | | 1.30 | | | |
| | Average wind m. p. h. on stormy days | | 5.7 | | 7.0 | | 8.1 | | 6.4 | | 7.9 | | 9.9 | | | |

# DEGREE-DAY NORMALS OVER THE UNITED STATES

By A. G. TOPIL

[Weather Bureau, Lincoln, Nebr., February 1937]

Because of the increased interest in degree-days, and the increased understanding of them as heating units by the general public, it has become more and more desirable during recent years to prepare normals by which to compare not only different winters in one place, but also the severity of a certain winter, or perhaps the normal winter, at two or more different places. This paper presents normal numbers of degree-days per month and per heating season for 158 first-order Weather Bureau stations over the United States. The normals are presented with the knowledge that there are some weaknesses in the method of calculation, but with the assurance that whatever error may be present is such that it will not materially detract from the value of the data in comparisons.

The number of degree-days is defined to be the difference between the mean temperature and 65°, applicable only when the mean temperature is below 65°, as a negative number of degree-days has no meaning. It is considered that for every degree that the mean temperature drops below 65°, a unit amount of heat must be used to keep a building at the optimum temperature. A day with the mean temperature of 64° will add one degree-day to the month's total; whereas a day with a mean temperature of 50° will require 15 units of heat and therefore will add 15 degree-days. Summing up the number of units for the individual days over a specified period, the total for a month, season, or any desired period is obtained.

A comparative table of the normal number of degree-days is of value because it is a very good measure of the severity of winters at various places. The mean annual temperature at two places is obviously not a good measure, for one may be comparatively mild throughout the year and the other have a hot summer and a cold winter, yet their mean annual temperatures may be nearly the same. For example, San Francisco, Calif., and Wichita, Kans., have annual mean temperatures of 56.1°, but the annual number of degree-days for San Francisco is 3,244, while that for Wichita is 4,558, which indicates a difference in winter severity of 1,314 degree-days, or over 40 percent.

Also, judging the winter severity at a station by its January mean temperature or by the mean winter (December, January, and February) temperature may lead to some erroneous conclusions due to the fact that at some stations the length of the winter may be of greater importance than its coldness. The normal seasonal degree-days take into consideration both the length and the coldness of the heating period.

Table 1 gives the monthly and annual normal numbers of degree-days at 158 cities in the United States. They are computed from tables given in Normals of Daily Temperature for the United States, by Charles F. Marvin and P. C. Day.[1] Whenever the mean temperature of every day during the month was less than 64.6°, the following equation was used in computation:

$$\text{Number of degree-days} = (65 - T)N$$

where $T$ is the mean monthly temperature and $N$ the number of days in the month. During a month when the mean temperature of any day exceeded 64.5° it was obvious that error would come in, and so for these months the degree-days were computed by individual days and totaled to find the monthly amount.

This method of calculation will not give quite the same results as a long time average of degree-days. At many stations the mean range of temperature is large, and when the mean temperature approaches the limiting value of 65° the heating units, as computed from averages, will be too few. This is readily illustrated by two days having mean temperatures of 60° and 70°, respectively. Taken individually they will contribute five degree-days, but if averaged first they will contribute none.

In an attempt to determine the magnitude of this error, the records of Lincoln, Nebr., were used and the degree-days for 50 years (July 1886–June 1936, inclusive) were computed by days, totaled, and averaged. It was found that the actual average was 6,113 degree-days as compared to the normal of 6,053 obtained by the previously used method, which indicates a discrepancy of less than 1 percent.

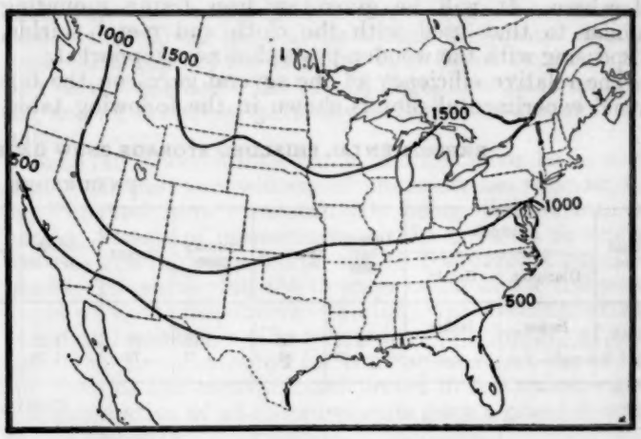



FIGURE 1.—Average number of degree-days for January.

The periods of years used in computing the two values were not identical, because the normal temperatures had been adjusted to cover a longer time; also a number of years of record had been added since the normal temperature had been computed. This may be the reason why the error is not as great as had been expected. However, since the error could scarcely appear at any time except from May through October at this station (other monthly means were far below 65°), the values for these months alone were taken and it was found that the actual average was 181 degree-days greater than the computed normal. This still remains less than 3 percent of the normal seasonal total, and since for all stations it would be of the same sign and quite small, it probably would not differ greatly from station to station and so would not greatly affect the usefulness of the normals in comparisons.

Figure 1 shows the January normal number of degree-days over the United States. The lines on this map follow closely the lines of January's actual mean temperature (not sea-level temperature, as is frequently published), which is as would be expected.

Figure 2 shows the annual normal number of degree-days, and considerable difference from the annual mean

[1] Normals of Daily Temperatures for the United States, MONTHLY WEATHER REVIEW SUPPLEMENT No. 25, Charles F. Marvin and P. C. Day.

temperature map is apparent. This difference is more easily shown by quoting individual cases. San Francisco and Wichita have already been mentioned. Portland, Oreg., and Concordia, Kans., have identical mean annual temperatures, but have a difference of 960 degree-days

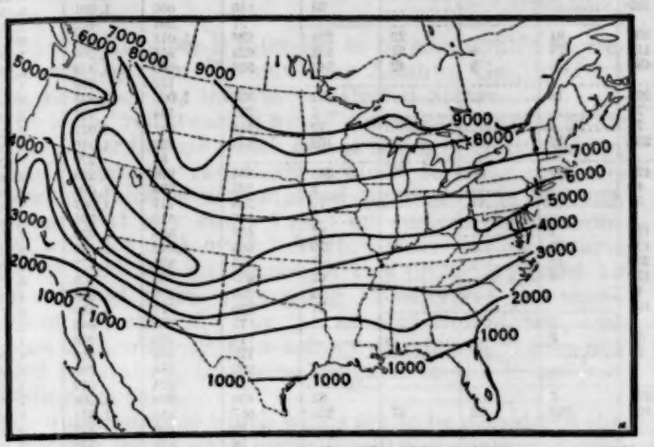



FIGURE 2.—Average annual number of degree-days.

in their annual total, which would be equivalent to 3 months averaging 10 degrees colder. Santa Fe, N. Mex., Erie, Pa., and Dubuque, Iowa, have nearly equal annual mean temperatures but have a range in number of annual degree-days of nearly 700. Los Angeles, Calif., and Little Rock, Ark., have nearly equal mean temperatures, but their annual degree-days number 1,472 and 2,863, respectively, which show one to be 94 percent more severe than the other.

That January, the coldest month, cannot be taken as a test of the severity of the entire winter is seen by comparing the two degree-day maps. However, here again, individual examples are still more impressive. Columbia, Mo., and Salt Lake City, Utah, have identical January temperatures and degree-day normals, but their annual number of degree-days differs by 612. Charleston, S. C., and San Francisco, Calif., have equal January normals, but the annual totals of their degree-days differ by 88 percent. Finally Seattle, Wash., and Fort Smith, Ark., have equal January temperatures, but their annual numbers of degree-days differ by 1,995; conversely, the annual totals of degree-days at Seattle, Wash., and Topeka, Kans., are nearly the same, but their January amounts are 790 and 1,159, respectively.

It is evident that neither January mean temperatures nor the annual mean temperatures give a true indication of the comparative severity of the cold season at various places. The mean winter temperature, which generally means December, January, and February, does not take into consideration the varying length of the heating season at various places. Normals of degree-days combine the entire winter into one quantity which is easily mapped and which results in easy comparison of stations, and therefore appears to be more practicable than any other known method of comparing the severity of winters.

TABLE I.—*Average number of degree-days*

| Stations | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abilene, Tex. | 645 | 498 | 264 | 36 | | | | | | 39 | 345 | 589 | 2,416 |
| Albany, N. Y. | 1,299 | 1,145 | 1,001 | 546 | 177 | 1 | | | 69 | 400 | 771 | 1,132 | 6,541 |
| Alpena, Mich. | 1,423 | 1,316 | 1,224 | 792 | 450 | 138 | 2 | 34 | 222 | 555 | 918 | 1,246 | 8,320 |
| Amarillo, Tex. | 921 | 753 | 561 | 276 | 49 | | | | | 226 | 585 | 868 | 4,239 |
| Atlanta, Ga. | 694 | 552 | 403 | 120 | | | | | | 80 | 387 | 629 | 2,865 |
| Atlantic City, N. J. | 1,008 | 879 | 818 | 516 | 214 | 8 | | | 10 | 251 | 582 | 887 | 5,173 |
| Augusta, Ga. | 558 | 423 | 279 | 45 | | | | | | 40 | 315 | 524 | 2,184 |
| Baker, Oreg. | 1,243 | 1,008 | 849 | 594 | 412 | 192 | 12 | 27 | 270 | 570 | 870 | 1,169 | 7,216 |
| Baltimore, Md. | 967 | 829 | 704 | 342 | 47 | | | | 2 | 211 | 561 | 862 | 4,525 |
| Binghamton, N. Y. | 1,268 | 1,148 | 1,004 | 588 | 236 | 18 | | | 113 | 465 | 789 | 1,141 | 6,770 |
| Birmingham, Ala. | 617 | 476 | 298 | 58 | | | | | | 51 | 333 | 577 | 2,410 |
| Bismarck, N. Dak. | 1,773 | 1,532 | 1,265 | 687 | 326 | 55 | | 5 | 207 | 623 | 1,095 | 1,559 | 9,127 |
| Block Island, R. I. | 1,054 | 969 | 918 | 630 | 378 | 95 | | | 56 | 313 | 612 | 899 | 5,924 |
| Boise, Idaho | 1,091 | 846 | 691 | 438 | 245 | 30 | | | 102 | 431 | 720 | 1,020 | 5,614 |
| Boston, Mass. | 1,150 | 1,014 | 911 | 558 | 245 | 13 | | | 61 | 353 | 690 | 1,008 | 6,003 |
| Brownsville, Tex. | 161 | 68 | | | | | | | | | 4 | 118 | 351 |
| Buffalo, N. Y. | 1,252 | 1,140 | 1,051 | 666 | 322 | 41 | | | 81 | 406 | 768 | 1,091 | 6,818 |
| Burlington, Vt. | 1,432 | 1,277 | 1,113 | 651 | 264 | 21 | | | 140 | 490 | 861 | 1,259 | 7,508 |
| Cairo, Ill. | 933 | 742 | 552 | 207 | 3 | | | | | 147 | 531 | 843 | 3,958 |
| Charles City, Iowa | 1,590 | 1,341 | 1,063 | 558 | 223 | 12 | | | 124 | 508 | 960 | 1,383 | 7,762 |
| Charleston, S. C. | 468 | 353 | 236 | 37 | | | | | | 8 | 207 | 412 | 1,721 |
| Charlotte, N. C. | 738 | 591 | 453 | 156 | | | | | | 111 | 432 | 682 | 3,163 |
| Chattanooga, Tenn. | 738 | 585 | 428 | 141 | | | | | | 106 | 438 | 673 | 3,109 |
| Cheyenne, Wyo. | 1,224 | 1,056 | 989 | 723 | 456 | 138 | | 13 | 240 | 626 | 906 | 1,132 | 7,503 |
| Chicago, Ill. | 1,237 | 1,053 | 890 | 519 | 202 | 3 | | | 17 | 307 | 714 | 1,085 | 6,027 |
| Cincinnati, Ohio | 1,076 | 902 | 747 | 378 | 71 | | | | 10 | 268 | 675 | 980 | 5,127 |
| Cleveland, Ohio | 1,194 | 1,053 | 942 | 564 | 220 | 6 | | | 47 | 353 | 723 | 1,048 | 6,150 |
| Columbia, Mo. | 1,110 | 932 | 694 | 303 | 48 | | | | 5 | 260 | 651 | 986 | 4,989 |
| Columbia, S. C. | 589 | 470 | 304 | 63 | | | | | | 54 | 330 | 552 | 2,362 |
| Columbus, Ohio | 1,128 | 960 | 803 | 414 | 93 | | | | 15 | 304 | 693 | 1,011 | 5,421 |
| Concord, N. H. | 1,345 | 1,182 | 1,060 | 648 | 332 | 68 | | 4 | 171 | 474 | 819 | 1,184 | 7,287 |
| Concordia, Kans. | 1,197 | 986 | 744 | 345 | 71 | | | | 6 | 282 | 708 | 1,063 | 5,402 |
| Corpus Christi, Tex. | 279 | 185 | 22 | | | | | | | | 41 | 217 | 744 |
| Davenport, Iowa | 1,339 | 1,123 | 896 | 453 | 117 | | | | 27 | 350 | 780 | 1,175 | 6,260 |
| Dayton, Ohio | 1,100 | 941 | 760 | 402 | 87 | | | | 15 | 310 | 690 | 1,004 | 5,309 |
| Denver, Colo. | 1,091 | 904 | 797 | 537 | 273 | 18 | | | 76 | 428 | 756 | 1,014 | 5,894 |
| Des Moines, Iowa | 1,302 | 1,156 | 902 | 447 | 117 | | | | 28 | 360 | 798 | 1,209 | 6,409 |
| Detroit, Mich. | 1,259 | 1,112 | 980 | 564 | 217 | 4 | | | 58 | 388 | 771 | 1,107 | 6,460 |
| Dodge City, Kans. | 1,116 | 890 | 688 | 342 | 65 | | | | 3 | 276 | 672 | 1,004 | 5,056 |
| Dubuque, Iowa | 1,423 | 1,198 | 961 | 492 | 148 | | | | 53 | 406 | 840 | 1,249 | 6,770 |
| Duluth, Minn. | 1,770 | 1,501 | 1,280 | 840 | 549 | 234 | 32 | 74 | 297 | 648 | 1,050 | 1,522 | 9,797 |
| Eastport, Maine | 1,383 | 1,218 | 1,119 | 780 | 536 | 297 | 143 | 133 | 276 | 542 | 849 | 1,200 | 8,476 |
| Elkins, W. Va. | 1,073 | 935 | 775 | 486 | 180 | 3 | | | 71 | 394 | 741 | 1,001 | 5,659 |
| El Paso, Tex. | 620 | 448 | 285 | 59 | | | | | | 72 | 369 | 623 | 2,476 |
| Erie, Pa. | 1,184 | 1,067 | 976 | 597 | 254 | 13 | | | 55 | 360 | 708 | 1,026 | 6,240 |
| Escanaba, Mich. | 1,538 | 1,389 | 1,265 | 813 | 477 | 130 | | 29 | 237 | 589 | 987 | 1,321 | 8,745 |
| Eureka, Calif. | 561 | 498 | 518 | 453 | 403 | 321 | 294 | 279 | 273 | 353 | 417 | 521 | 4,891 |
| Evansville, Ind. | 976 | 804 | 592 | 249 | 16 | | | | | 174 | 552 | 865 | 4,228 |
| Fort Smith, Ark. | 790 | 622 | 384 | 97 | | | | | | 89 | 420 | 710 | 3,112 |
| Fort Worth, Tex. | 608 | 468 | 226 | 25 | | | | | | 24 | 285 | 542 | 2,178 |
| Fresno, Calif. | 583 | 389 | 310 | 144 | 7 | | | | | 53 | 324 | 553 | 2,393 |
| Galveston, Tex. | 347 | 244 | 82 | | | | | | | | 64 | 267 | 1,004 |
| Grand Haven, Mich. | 1,262 | 1,142 | 1,032 | 639 | 336 | 51 | | | 122 | 443 | 795 | 1,107 | 6,919 |
| Grand Junction, Col. | 1,271 | 899 | 663 | 378 | 123 | | | | 31 | 378 | 771 | 1,162 | 5,676 |
| Grand Rapids, Mich. | 1,256 | 1,156 | 980 | 540 | 217 | 4 | | | 78 | 428 | 798 | 1,132 | 6,589 |
| Green Bay, Wis. | 1,528 | 1,333 | 1,128 | 654 | 313 | 35 | | | 139 | 512 | 930 | 1,324 | 7,896 |

TABLE I.—*Average number of degree-days*—Continued

| Stations | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenville, S. C | 766 | 608 | 468 | 192 | 8 | | | | | 148 | 462 | 707 | 3,359 |
| Hannibal, Mo | 1,175 | 988 | 744 | 348 | 63 | | | | 9 | 279 | 687 | 1,038 | 5,331 |
| Harrisburg, Pa | 1,116 | 974 | 809 | 423 | 102 | | | | 23 | 316 | 666 | 1,001 | 5,430 |
| Hatteras, N. C | 555 | 493 | 403 | 156 | 1 | | | | | 27 | 261 | 462 | 2,358 |
| Havre, Mont | 1,615 | 1,439 | 1,175 | 639 | 360 | 94 | | 22 | 258 | 636 | 1,014 | 1,383 | 8,635 |
| Helena, Mont | 1,389 | 1,176 | 1,011 | 645 | 415 | 174 | 8 | 21 | 252 | 623 | 954 | 1,365 | 7,933 |
| Houghton, Mich | 1,559 | 1,436 | 1,308 | 819 | 480 | 150 | 3 | 42 | 243 | 598 | 990 | 1,339 | 8,967 |
| Houston, Tex | 381 | 255 | 56 | | | | | | | | 122 | 329 | 1,143 |
| Huron, S. Dak | 1,665 | 1,420 | 1,119 | 597 | 267 | 18 | | | 112 | 536 | 1,005 | 1,435 | 8,174 |
| Independence, Calif | 831 | 638 | 512 | 297 | 72 | | | | 7 | 232 | 534 | 797 | 3,920 |
| Indianapolis, Ind | 1,135 | 949 | 775 | 387 | 77 | | | | 12 | 288 | 681 | 1,017 | 5,321 |
| Ithaca, N. Y | 1,262 | 1,134 | 1,032 | 600 | 232 | 12 | | | 102 | 431 | 792 | 1,116 | 6,713 |
| Jacksonville, Fla | 298 | 196 | 76 | | | | | | | | 88 | 270 | 928 |
| Kalispell, Mont | 1,383 | 1,168 | 995 | 642 | 422 | 219 | 33 | 69 | 345 | 666 | 978 | 1,243 | 8,163 |
| Kansas City, Mo | 1,141 | 946 | 691 | 306 | 43 | | | | 2 | 226 | 639 | 1,008 | 5,002 |
| Keokuk, Iowa | 1,243 | 1,028 | 809 | 381 | 59 | | | | 10 | 298 | 717 | 1,097 | 5,642 |
| Knoxville, Tenn | 812 | 647 | 505 | 210 | 8 | | | | | 160 | 513 | 766 | 3,621 |
| La Crosse, Wis | 1,516 | 1,282 | 1,038 | 534 | 177 | 1 | | | 87 | 456 | 894 | 1,324 | 7,309 |
| Lander, Wyo | 1,448 | 1,190 | 1,011 | 678 | 428 | 135 | | 18 | 279 | 666 | 1,041 | 1,383 | 8,277 |
| Lansing, Mich | 1,321 | 1,179 | 1,017 | 582 | 251 | 15 | | | 107 | 456 | 825 | 1,172 | 6,925 |
| Lewiston, Idaho | 1,008 | 784 | 608 | 363 | 170 | 9 | | | 83 | 418 | 708 | 908 | 5,059 |
| Lexington, Ky | 905 | 829 | 660 | 321 | 46 | | | | 2 | 236 | 606 | 905 | 4,600 |
| Lincoln, Nebr | 1,308 | 1,089 | 852 | 405 | 107 | | | | 21 | 335 | 777 | 1,150 | 6,013 |
| Little Rock, Ark | 732 | 563 | 372 | 92 | | | | | | 72 | 387 | 645 | 2,863 |
| Los Angeles, Calif | 322 | 266 | 232 | 168 | 87 | 3 | | | | 11 | 123 | 260 | 1,472 |
| Louisville, Ky | 949 | 778 | 608 | 258 | 16 | | | | | 178 | 549 | 849 | 4,185 |
| Lynchburg, Va | 852 | 692 | 549 | 231 | 9 | | | | 1 | 202 | 534 | 790 | 3,860 |
| Macon, Ga | 564 | 440 | 257 | 51 | | | | | | 53 | 324 | 542 | 2,231 |
| Madison, Wis | 1,497 | 1,285 | 1,066 | 588 | 229 | 7 | | | 85 | 456 | 894 | 1,308 | 7,415 |
| Marquette, Mich | 1,510 | 1,364 | 1,246 | 816 | 496 | 183 | 12 | 37 | 225 | 567 | 951 | 1,314 | 8,721 |
| Memphis, Tenn | 747 | 580 | 394 | 98 | | | | | | 76 | 399 | 663 | 2,957 |
| Meridian, Miss | 558 | 431 | 245 | 41 | | | | | | 56 | 324 | 536 | 2,191 |
| Milwaukee, Wis | 1,376 | 1,182 | 1,020 | 636 | 338 | 52 | | | 80 | 431 | 831 | 1,206 | 7,152 |
| Minneapolis, Minn | 1,621 | 1,375 | 1,097 | 558 | 226 | 9 | | | 113 | 499 | 978 | 1,407 | 7,883 |
| Mobile, Ala | 418 | 288 | 164 | 11 | | | | | | 3 | 192 | 397 | 1,473 |
| Modena, Utah | 1,187 | 952 | 831 | 570 | 356 | 62 | | | 150 | 527 | 858 | 1,144 | 6,637 |
| Montgomery, Ala | 521 | 375 | 223 | 24 | | | | | | 24 | 276 | 484 | 1,927 |
| Moorhead, Minn | 1,897 | 1,593 | 1,311 | 732 | 307 | 34 | | 7 | 204 | 636 | 1,137 | 1,658 | 9,516 |
| Nantucket, Mass | 1,045 | 960 | 914 | 648 | 394 | 120 | | | 69 | 335 | 618 | 905 | 6,008 |
| Nashville, Tenn | 818 | 655 | 490 | 180 | 3 | | | | | 130 | 480 | 744 | 3,500 |
| New Haven, Conn | 1,141 | 1,008 | 905 | 534 | 220 | 10 | | | 55 | 347 | 690 | 1,008 | 5,918 |
| New Orleans, La | 335 | 216 | 71 | | | | | | | | 104 | 291 | 1,017 |
| New York, N. Y | 1,057 | 944 | 846 | 468 | 139 | | | | 12 | 270 | 624 | 930 | 5,290 |
| Norfolk, Va | 756 | 624 | 521 | 246 | 19 | | | | | 89 | 408 | 679 | 3,342 |
| Northfield, Vt | 1,544 | 1,361 | 1,197 | 741 | 378 | 111 | | 53 | 267 | 604 | 966 | 1,383 | 8,605 |
| North Head, Wash | 710 | 616 | 614 | 525 | 437 | 306 | 242 | 229 | 255 | 375 | 504 | 648 | 5,461 |
| North Platte, Nebr | 1,305 | 1,075 | 880 | 492 | 195 | 4 | | | 97 | 474 | 852 | 1,187 | 6,561 |
| Oklahoma City, Okla | 887 | 711 | 465 | 156 | 3 | | | | | 120 | 486 | 797 | 3,625 |
| Omaha, Nebr | 1,336 | 1,106 | 868 | 414 | 91 | | | | 15 | 332 | 795 | 1,197 | 6,154 |
| Oswego, N. Y | 1,274 | 1,151 | 1,048 | 642 | 304 | 34 | | | 113 | 428 | 783 | 1,116 | 6,893 |
| Palestine, Tex | 521 | 386 | 183 | 12 | | | | | | 17 | 234 | 468 | 1,821 |
| Parkersburg, W. Va | 1,008 | 862 | 688 | 348 | 55 | | | | 10 | 276 | 636 | 924 | 4,807 |
| Pensacola, Fla | 388 | 274 | 146 | 6 | | | | | | | 144 | 341 | 1,299 |
| Philadelphia, Pa | 1,004 | 871 | 750 | 387 | 77 | | | | 3 | 223 | 579 | 890 | 4,784 |
| Phoenix, Ariz | 428 | 277 | 133 | 4 | | | | | | | 160 | 403 | 1,405 |
| Pierre, S. Dak | 1,519 | 1,299 | 1,038 | 546 | 217 | 3 | | | 62 | 471 | 942 | 1,339 | 7,436 |
| Pittsburgh, Pa | 1,063 | 916 | 787 | 414 | 91 | | | | 15 | 288 | 654 | 955 | 5,183 |
| Pocatello, Idaho | 1,249 | 1,011 | 856 | 570 | 347 | 88 | | | 144 | 515 | 849 | 1,156 | 6,785 |
| Port Huron, Mich | 1,324 | 1,184 | 1,073 | 660 | 304 | 38 | | | 102 | 450 | 825 | 1,150 | 7,119 |
| Portland, Maine | 1,321 | 1,154 | 1,029 | 660 | 363 | 79 | | 5 | 162 | 468 | 810 | 1,189 | 7,210 |
| Portland, Oreg | 794 | 641 | 561 | 396 | 251 | 80 | | | 100 | 335 | 546 | 738 | 4,442 |
| Pueblo, Colo | 1,088 | 899 | 725 | 447 | 180 | 2 | | | 47 | 403 | 768 | 1,038 | 5,597 |
| Raleigh, N. C | 741 | 610 | 459 | 168 | 1 | | | | | 98 | 420 | 682 | 3,179 |
| Rapid City, S. Dak | 1,333 | 1,165 | 1,004 | 621 | 341 | 49 | | | 140 | 512 | 873 | 1,181 | 7,219 |
| Red Bluff, Calif | 595 | 437 | 353 | 180 | 15 | | | | | 51 | 336 | 586 | 2,553 |
| Richmond, Va | 840 | 711 | 552 | 252 | 15 | | | | | 167 | 501 | 781 | 3,819 |
| Rochester, N. Y | 1,252 | 1,131 | 1,029 | 603 | 245 | 13 | | | 81 | 418 | 789 | 1,107 | 6,668 |
| Roseburg, Oreg | 732 | 605 | 555 | 420 | 279 | 76 | | | 67 | 344 | 573 | 719 | 4,376 |
| Sacramento, Calif | 595 | 417 | 332 | 58 | | | | | | 73 | 342 | 583 | 2,400 |
| Saginaw, Mich | 1,342 | 1,207 | 1,038 | 603 | 251 | 9 | | | 100 | 456 | 828 | 1,172 | 7,006 |
| St. Louis, Mo | 1,051 | 846 | 648 | 267 | 15 | | | | | 191 | 588 | 933 | 4,539 |
| St. Paul, Minn | 1,624 | 1,378 | 1,113 | 582 | 220 | 7 | | | 113 | 508 | 975 | 1,426 | 7,946 |
| Salt Lake City, Utah | 1,110 | 874 | 722 | 462 | 236 | 12 | | | 54 | 388 | 717 | 1,026 | 5,601 |
| San Antonio, Tex | 394 | 269 | 70 | | | | | | | | 138 | 350 | 1,221 |
| San Diego, Calif | 332 | 277 | 257 | 195 | 130 | 36 | | | | 42 | 159 | 279 | 1,707 |
| Sandusky, Ohio | 1,200 | 1,053 | 927 | 534 | 180 | | | | 27 | 332 | 717 | 1,048 | 6,018 |
| San Francisco, Calif | 468 | 358 | 335 | 300 | 254 | 195 | 202 | 183 | 123 | 140 | 261 | 425 | 3,244 |
| San Luis Obispo, Calif | 415 | 333 | 319 | 276 | 211 | 87 | 7 | | 14 | 99 | 231 | 372 | 2,364 |
| Santa Fe, N. Mex | 1,122 | 893 | 784 | 549 | 288 | 30 | | | 122 | 453 | 783 | 1,063 | 6,087 |
| Sault Ste. Marie, Mich | 1,603 | 1,467 | 1,345 | 828 | 496 | 192 | 37 | 90 | 285 | 632 | 990 | 1,380 | 9,345 |
| Savannah, Ga | 422 | 308 | 186 | 15 | | | | | | 7 | 195 | 391 | 1,524 |
| Scranton, Pa | 1,190 | 1,056 | 908 | 507 | 174 | 1 | | | 74 | 406 | 735 | 1,063 | 6,114 |
| Seattle, Wash | 790 | 669 | 623 | 468 | 326 | 180 | 59 | 59 | 207 | 422 | 582 | 722 | 5,107 |
| Shreveport, La | 558 | 395 | 208 | 16 | | | | | | 24 | 270 | 493 | 1,964 |
| Sioux City, Iowa | 1,463 | 1,232 | 1,001 | 516 | 142 | | | | 68 | 437 | 894 | 1,299 | 7,052 |
| Spokane, Wash | 1,162 | 944 | 784 | 498 | 294 | 72 | | | 174 | 518 | 795 | 1,071 | 6,312 |
| Springfield, Ill | 1,194 | 994 | 769 | 369 | 71 | | | | 7 | 285 | 684 | 1,032 | 5,405 |
| Springfield, Mo | 976 | 834 | 614 | 270 | 41 | | | | 2 | 211 | 579 | 893 | 4,420 |
| Tacoma, Wash | 812 | 683 | 645 | 489 | 338 | 189 | 68 | 74 | 231 | 450 | 612 | 756 | 5,347 |
| Tampa, Fla | 143 | 87 | 4 | | | | | | | | 4 | 121 | 359 |
| Toledo, Ohio | 1,215 | 1,056 | 921 | 522 | 174 | | | | 41 | 360 | 738 | 1,073 | 6,100 |
| Topeka, Kans | 1,159 | 952 | 694 | 309 | 49 | | | | 3 | 248 | 666 | 1,023 | 5,103 |
| Valentine, Nebr | 1,429 | 1,221 | 1,014 | 579 | 273 | 19 | | | 88 | 487 | 912 | 1,252 | 7,274 |
| Vicksburg, Miss | 521 | 370 | 202 | 19 | | | | | | 22 | 252 | 465 | 1,851 |
| Walla Walla, Wash | 1,001 | 781 | 586 | 357 | 167 | 9 | | | 58 | 356 | 666 | 914 | 4,895 |
| Washington, D. C | 980 | 832 | 694 | 351 | 61 | | | | 3 | 236 | 594 | 880 | 4,631 |
| Wichita, Kans | 1,045 | 857 | 617 | 258 | 34 | | | | | 199 | 606 | 942 | 4,558 |
| Williston, N. Dak | 1,817 | 1,593 | 1,305 | 690 | 341 | 75 | | 16 | 252 | 670 | 1,134 | 1,587 | 9,405 |
| Wilmington, N. C | 574 | 479 | 363 | 94 | | | | | | 31 | 270 | 493 | 2,304 |
| Winnemucca, Nev | 1,128 | 882 | 775 | 549 | 344 | 76 | | | 175 | 518 | 798 | 1,085 | 6,330 |
| Yankton, S. Dak | 1,479 | 1,235 | 986 | 513 | 174 | | | | 53 | 431 | 891 | 1,308 | 7,070 |
| Yuma, Ariz | 329 | 179 | 38 | | | | | | | | 89 | 304 | 939 |

# THE RAIN-BEARING WINDS AT KNOXVILLE, TENNESSEE

By STERLING BUNCH

[Weather Bureau, Oklahoma City, Okla., January 1936]

The present paper is intended to be comparable to previous ones by Von Hermann for Atlanta, Ga.,[1] and by Thos. R. Reed [2] for the western United States.

The term "rain-bearing wind" connotes a current of air *from* which or *through* which rain is falling. In this paper, we shall consider "rain-bearing wind" to mean any surface wind which is accompanied by rain; it is obvious, however, that any study based on surface observations alone will not tell much about the free-air conditions involved, and the limitations of this procedure must be kept in mind when attempting to interpret the significance of the results. For the sake of consistency, and because of their rarity, rain-hours with wind calm were not treated separately, but were assigned to the hours just preceding the calm.

The question as to which winds are to be considered the rain-bearing winds at a given locality is somewhat ambiguous; e. g., do we mean only the prevailing direction of the wind during rain? If so, then at a station like Knoxville, where the winds are profoundly influenced by local topography, the prevailing wind over a long period of time will be the prevailing rain-bearing wind. We may mean both the prevailing direction of the wind during rain and the total amount of precipitation contributed by each direction; then we shall want to know, in addition, the average hourly rates for each wind direction, and, most important of all, *the ratio between the total rain-wind-hours and the total wind-hours for each direction.* In the treatment of Knoxville data, four specific questions were considered: (1) What is the prevailing direction of the wind during rain? (2) What wind direction contributes the greatest total amount of rainfall? (3) With what wind direction do the highest hourly rates of rainfall occur? (4) What wind direction is most likely to be accompanied by rain?

The determination of the ratio of total wind-hours to total rain-wind-hours perhaps more nearly eliminates the *mechanical* effect of mountains in changing winds to one or two prevailing directions than could any other approach to the problem based on surface observations alone.

The Knoxville data were tabulated for the 20-year period, 1916 to 1935, inclusive. Only hours with measureable amounts of precipitation were considered, since the *frequencies* and *amounts* would not have been numerically comparable had traces been counted. Precipitation from melted snow contributes less than 2 percent of the total annual precipitation at Knoxville, and the hourly amounts have been estimated. These were counted and given the same weight as the tipping bucket records. The locations of the anemometer and the rain gage during the period considered represent three different elevations and exposures, all in downtown Knoxville.

Knoxville is situated between two mountain ranges, the Cumberlands to the west and northwest with extreme elevations of about 2,000 feet above sea level, and the Smoky Mountains to the east and southeast with extreme elevations of about 6,500 feet above sea level. The valley with an average elevation of about 1,000 feet runs roughly southwest and northeast; and the wind blows from each of these two directions about half the time.

The table contains the results of the investigation. The calendar season is probably not the most desirable time division for such a study; but in this case it was used as a matter of convenience, and because this division happens to agree fairly well with the changes in prevailing winds and rainfall at Knoxville. To simplify the table the totals of wind-hours and rainfall amounts are not included.

During the spring and summer the rain-wind frequencies and rain-fall amount percentages follow closely the wind frequencies; but during the autumn months the number of rain hours is approximately the same for the prevailing northeast winds and for the southwest wind, while the greater amount of rainfall still comes with a southwest wind as during the two preceding seasons. A different picture is presented, however, during the winter months.

Without considering the hourly rates and the rain probabilities with a given wind, we should conclude that only the southwest and northeast winds are of any importance in producing rain over the Tennessee Valley at this point; but when we glance at the last two rows under each season and for the year as a whole, we find that the northeast wind loses its importance as a wet wind and the southwest wind becomes the driest wind that blows.

The hourly rate of the southeast rainfall during the spring and summer is possibly too high because a few excessive falls accompanying thunderstorms happened to occur with a southeast wind. This seems to be borne out by the fact that the southeast wind shows no such excessive variation in rate during the autumn and winter months. On the other hand, this excessive rate may be real and directly due to the thunderstorm winds, since the northwest wind shows an hourly rate for these seasons almost as high. Unfortunately, sufficient data are not available for determining the prevailing direction of translation of thunderstorms in the Tennessee Valley. In any case, the prevailing winds at Knoxville are certainly not the "wettest" winds. During the spring and summer the heaviest rains occur with southeast and northwest winds, during the autumn, with a west wind, and during the winter, with a south wind, although the variation in hourly rates between directions in winter is too small to be significant.

The spring wind most likely to be accompanied by rain is again southeast, with 11.7 hours of rain per 100 hours of wind, but the northwest wind is a close second. In the summer the northwest wind becomes the most probable rain wind, although with only a slight fraction over the south and southeast winds. During the autumn months the west wind is the most likely rain-wind, and during the winter, the south wind.

For the year as a whole, 7.2 hours of rain occur every 100 hours, and falls at an average rate of 0.08 inches per hour. The southwest wind contributes the largest number of rain-hours and also the highest total rainfall, simply because that is the prevailing wind. The southeast wind appears to bring the heaviest falls, bearing in mind what has already been said with regard to a possible purely fortuitous factor in this tabulation; and finally, when the wind blows from northwest in this valley it is more likely to be accompanied by rain than any other wind.

The writer wishes to express his appreciation to both Mr. J. E. Stork and Mr. J. E. Sanders, of the Knoxville

[1] The Rain-bearing Winds of Atlanta, Ga., MONTHLY WEATHER REVIEW, 53: 404-407, 1925.

[2] Rain-bearing Winds in the Far Western States, MONTHLY WEATHER REVIEW, 55: 228-233, 1927.

Weather Bureau Office, the former for his assistance in tabulating the data, and the latter for checking and general criticism of the manuscript.

*The rain-bearing winds at Knoxville, Tenn., 1916–35, inclusive*

| Direction | N. | NE. | E. | SE. | S. | SW. | W. | NW. | Annual |
|---|---|---|---|---|---|---|---|---|---|
| SPRING | | | | | | | | | |
| Prevailing wind (percent) | 14 | 18 | 7 | 3 | 9 | 31 | 11 | 7 | ------ |
| Prevailing rain-wind (percent) | 12 | 20 | 9 | 4 | 11 | 25 | 10 | 9 | 27 |
| Total amount of rain (percent) | 11 | 19 | 9 | 6 | 11 | 24 | 11 | 9 | 27 |
| Average hourly rate (inches) | .07 | .07 | .08 | .10 | .08 | .07 | .08 | .07 | .08 |
| Ratio of rain-hours to wind-hours (hours per 100 hours) | 6.5 | 8.5 | 9.0 | 11.7 | 9.8 | 6.1 | 6.9 | 10.3 | 7.7 |
| SUMMER | | | | | | | | | |
| Prevailing wind (percent) | 13 | 19 | 9 | 4 | 11 | 30 | 10 | 4 | ------ |
| Prevailing rain-wind (percent) | 8 | 14 | 9 | 5 | 14 | 32 | 12 | 6 | 17 |
| Total amount of rain (percent) | 11 | 15 | 8 | 8 | 13 | 25 | 11 | 9 | 28 |
| Average hourly rate (inches) | .15 | .13 | .11 | .20 | .11 | .10 | .12 | .18 | .12 |
| Ratio of rain-hours to wind-hours (hours per 100 hours) | 3.3 | 3.7 | 5.3 | 6.5 | 6.5 | 5.4 | 6.0 | 6.7 | 5.7 |
| AUTUMN | | | | | | | | | |
| Prevailing wind (percent) | 14 | 28 | 10 | 4 | 8 | 21 | 9 | 6 | ------ |
| Prevailing rain-wind (percent) | 10 | 24 | 10 | 5 | 8 | 24 | 12 | 7 | 19 |

*The rain-bearing winds at Knoxville, Tenn., 1916–35, inclusive*—Con.

| Direction | N. | NE. | E. | SE. | S. | SW. | W. | NW. | Annual |
|---|---|---|---|---|---|---|---|---|---|
| AUTUMN—continued | | | | | | | | | |
| Total amount of rain (percent) | 9 | 21 | 11 | 4 | 9 | 25 | 14 | 7 | 18 |
| Average hourly rate (inches) | .07 | .06 | .08 | .07 | .08 | .08 | .09 | .07 | .07 |
| Ratio of rain-hours to wind-hours (hours per 100 hours) | 3.8 | 4.8 | 5.4 | 6.4 | 6.0 | 6.6 | 7.4 | 6.8 | 5.6 |
| WINTER | | | | | | | | | |
| Prevailing wind (percent) | 14 | 24 | 7 | 2 | 6 | 30 | 10 | 7 | ------ |
| Prevailing rain-wind (percent) | 13 | 31 | 8 | 2 | 8 | 21 | 10 | 7 | 37 |
| Total amount of rain (percent) | 13 | 32 | 9 | 2 | 9 | 19 | 9 | 7 | 27 |
| Average hourly rate (inches) | .06 | .06 | .06 | .06 | .06 | .05 | .06 | .06 | .06 |
| Ratio of rain-hours to wind hours (hours per 100 hours) | 9.5 | 13.6 | 11.0 | 11.6 | 15.0 | 7.5 | 9.7 | 11.2 | 10.5 |
| YEAR | | | | | | | | | |
| Prevailing wind (percent) | 14 | 22 | 9 | 3 | 8 | 28 | 10 | 6 | ------ |
| Prevailing rain-wind (percent) | 11 | 24 | 9 | 4 | 10 | 25 | 10 | 7 | 100 |
| Total amount of rain (percent) | 11 | 22 | 9 | 5 | 11 | 23 | 11 | 8 | 100 |
| Average hourly rate (inches) | .08 | .07 | .08 | .10 | .08 | .07 | .08 | .08 | .08 |
| Ratio of rain-hours to wind-hours (hours per 100 hour) | 6.2 | 7.7 | 7.4 | 8.5 | 8.7 | 6.4 | 7.5 | 9.0 | 7.2 |

## ANALYSES OF RAINS AND SNOWS AT MOUNT VERNON, IOWA, 1936–1937

By NICHOLAS KNIGHT

[Cornell College, Mount Vernon, Iowa, June 1937]

The analysis of the rains and snows at Mount Vernon, Iowa, was continued during 1936 and 1937. There were 36 samples of rain and only 6 samples of snow. We considered that 1 inch of rain on an acre weighs 226,875 pounds.

The snowstorm of December 5, 1936, was preceded by several weeks of drought, a possible explanation of the high chlorine and nitrate content of the snow. The storm of January 2, 1937, was mostly rain mixed with some snow, while the storm of January 6 contained some sleet; and on January 8 a considerable quantity of rain came down with the snow. The precipitation of January 20 was rain and sleet. The large amounts of chlorine in the precipitation of February 17 and 20 seemed to be due to the duststorms of that period. The rain of April 30 was accompanied by severe thunder and lightning. The storm of May 4 was accompanied by thunder and lightning and there was considerable hail. There was also much thunder and lightning with the rain of May 11.

*The rains and snows of Mount Vernon, Iowa, 1936–37*

PARTS PER MILLION

| No. | Date 1936–37 | Precipitation | | Chlorine | Free $NH_3$ | Alb. $NH_3$ | N in nitrate | N in nitrite | Sulphate |
|---|---|---|---|---|---|---|---|---|---|
| | | Amount | Kind | | | | | | |
| | | *Inches* | | | | | | | |
| 1 | June 14 | 0.12 | Rain | 3.55 | 0.64 | 0.36 | 1.0 | 0.01 | 0.0005 |
| 2 | June 16 | .40 | ...do | 3.55 | .28 | .48 | 1.5 | .015 | .0003 |
| 3 | Oct. 20 | .33 | ...do | 2.15 | .42 | .20 | .9 | .012 | .0002 |
| 4 | Nov. 1 | .80 | ...do | 5.00 | .45 | .60 | .15 | .020 | .00 |
| 5 | Nov. 2 | .40 | ...do | 3.50 | .32 | .45 | .10 | .03 | .0004 |

*The rains and snows of Mount Vernon, Iowa, 1936–37*—Continued

PARTS PER MILLION—Continued

| No. | Date 1936–37 | Precipitation | | Chlorine | Free $NH_3$ | Alb. $NH_3$ | N in nitrate | N in nitrite | Sulphate |
|---|---|---|---|---|---|---|---|---|---|
| | | Amount | Kind | | | | | | |
| | | *Inches* | | | | | | | |
| 6 | Nov. 8 | 2.00 | Snow | 2.13 | 0.60 | 0.40 | 0.13 | 0.03 | 0.0003 |
| 7 | Dec. 5 | 6.00 | ...do | 7.10 | .36 | .40 | 1.00 | .02 | Trace |
| 8 | Dec. 26 | .75 | Rain | 3.55 | .136 | .50 | .9 | .03 | .00 |
| 9 | Dec. 30 | .85 | ...do | 3.25 | .40 | .55 | 1.00 | .04 | .00 |
| 10 | Jan. 2 | .40 | ...do | 3.60 | .08 | .36 | 1.03 | .02 | Trace |
| 11 | Jan. 6 | .20 | ...do | 3.55 | .24 | .45 | 1.50 | .04 | .02 |
| 12 | Jan. 8 | 6.00 | Snow | 3.40 | .056 | .40 | 0.8 | .01 | .00 |
| 13 | Jan. 20 | .50 | Rain | 2.80 | .112 | .45 | .8 | .02 | .0008 |
| 14 | Jan. 30 | .75 | ...do | 4.00 | .056 | .40 | .9 | .15 | .012 |
| 15 | Feb. 15 | 3.00 | Snow | 3.50 | .35 | .45 | 1.5 | .02 | Trace |
| 16 | Feb. 17 | 3.00 | ...do | 10.00 | .28 | .42 | 2.00 | .015 | Trace |
| 17 | Feb. 19 | .33 | Rain | 11.15 | .02 | .50 | 1.7 | .020 | .0025 |
| 18 | Feb. 20 | 1.00 | ...do | 3.50 | .056 | .43 | 1.0 | .018 | .0011 |
| 19 | Mar. 4 | .67 | ...do | 3.60 | .06 | .36 | 1.2 | .020 | .00 |
| 20 | Mar. 20 | 4.00 | Snow | 3.55 | .08 | .42 | 2.3 | .03 | .0039 |
| 21 | Mar. 22 | .10 | Rain | 3.55 | .24 | .46 | 2.2 | .055 | .28 |
| 22 | Mar. 24 | .60 | ...do | 3.60 | .20 | .40 | .6 | .025 | .008 |
| 23 | Apr. 2 | 4.00 | Snow | 3.00 | .056 | .42 | .5 | .015 | .008 |
| 24 | Apr. 3 | 1.00 | Rain | 7.00 | .136 | .45 | .136 | .025 | .010 |
| 25 | Apr. 5 | .30 | ...do | 3.25 | .25 | .20 | .4 | .02 | .007 |
| 26 | Apr. 7 | .25 | ...do | 3.50 | .40 | .45 | .6 | .0175 | .005 |
| 27 | Apr. 15 | .17 | ...do | 1.42 | .48 | .20 | .75 | .05 | .004 |
| 28 | Apr. 21 | .80 | ...do | 7.10 | .42 | .35 | .70 | .04 | .0045 |
| 29 | Apr. 24 | .20 | ...do | 3.50 | .35 | .48 | .75 | .055 | .0044 |
| 30 | Apr. 25 | .15 | ...do | 4.00 | .36 | .20 | .5 | .035 | .006 |
| 31 | Apr. 28 | .20 | ...do | 2.9 | .136 | .45 | .7 | .053 | .004 |
| 32 | Apr. 29 | .60 | ...do | 2.13 | .24 | .44 | 1.2 | .036 | .0008 |
| 33 | May 2 | 1.00 | ...do | 1.42 | .40 | .32 | .3 | .04 | .0008 |
| 34 | May 3 | .30 | ...do | 1.05 | .18 | .36 | .63 | .025 | .00 |
| 35 | May 4 | .33 | ...do | 0.75 | .28 | .28 | .40 | .045 | .0044 |
| 36 | May 11 | .60 | ...do | 2.75 | .32 | .20 | .70 | .05 | .0007 |
| 37 | May 15 | .20 | ...do | 0.71 | .32 | .24 | .80 | .05 | .0044 |
| 38 | May 18 | .20 | ...do | 2.00 | .35 | .24 | 1.1 | .055 | .0028 |
| 39 | May 20 | .33 | ...do | 0.9 | .04 | .42 | .45 | .06 | .003 |
| 40 | May 27 | 1.25 | ...do | 0.7 | .136 | .20 | .72 | .074 | .002 |
| 41 | June 2 | .17 | ...do | 3.55 | .40 | .42 | .68 | .07 | .003 |
| 42 | June 5 | .38 | ...do | 3.00 | .36 | .35 | .65 | .04 | .001 |

*The rains and snows of Mount Vernon, Iowa, 1936–37*—Continued

POUNDS PER ACRE
[226,875 pounds per acre=1 inch]

| No. | Date 1936-37 | Precipitation | | Chlorine | Free $NH_3$ | Alb. $NH_3$ | N in nitrate | N in nitrite | Sulphate |
|---|---|---|---|---|---|---|---|---|---|
| | | Amount | Kind | | | | | | |
| | | *Inches* | | | | | | | |
| 1 | June 14 | 0.12 | Rain | 0.96 | 0.017 | 0.01 | 0.23 | 0.003 | 0.00001 |
| 2 | June 16 | .40 | do | .32 | .025 | .04 | .135 | .0014 | .00003 |
| 3 | Oct. 20 | .33 | do | .163 | .032 | .015 | .07 | .0009 | .00002 |
| 4 | Nov. 1 | .80 | do | .92 | .083 | .11 | .03 | .0037 | .00 |
| 5 | Nov. 2 | .40 | do | .319 | .029 | .041 | .009 | .0027 | .00004 |
| 6 | Nov. 8 | 2.00 | Snow | .081 | .028 | .015 | .005 | .001 | .00001 |
| 7 | Dec. 5 | 6.00 | do | .81 | .04 | .046 | .114 | .0023 | Trace |
| 8 | Dec. 26 | .75 | Rain | .6 | .023 | .085 | .15 | .005 | .00 |
| 9 | Dec. 30 | .85 | do | .63 | .077 | .106 | .193 | .0077 | .00 |
| 10 | Jan. 2 | .40 | do | .33 | .0073 | .033 | .094 | .0018 | Trace |
| 11 | Jan. 6 | .20 | do | .135 | .0091 | .017 | .057 | .0015 | .0023 |
| 12 | Jan. 8 | 6.00 | Snow | .384 | .0063 | .045 | .09 | .0011 | .00 |
| 13 | Jan. 20 | .50 | Rain | .0319 | .013 | .051 | .091 | .022 | .00007 |
| 14 | Jan. 30 | .75 | do | .68 | .010 | .068 | .15 | .0026 | .002 |
| 15 | Feb. 15 | 3.00 | Snow | .20 | .020 | .026 | .086 | .001 | Trace |
| 16 | Feb. 17 | 3.00 | do | .57 | .016 | .024 | .114 | .0009 | .0001 |
| 17 | Feb. 19 | .33 | Rain | .86 | .0015 | .038 | .129 | .00015 | .0002 |
| 18 | Feb. 20 | 1.00 | do | .79 | .0127 | .098 | .227 | .0041 | .0002 |
| 19 | Mar. 4 | .67 | do | .61 | .0102 | .0612 | .206 | .0034 | .00 |
| 20 | Mar. 20 | 4.00 | Snow | .27 | .0061 | .032 | .17 | .0023 | .0003 |
| 21 | Mar. 22 | .10 | Rain | .08 | .005 | .01 | .05 | .012 | .04 |
| 22 | Mar. 24 | .60 | do | .05 | .028 | .056 | .084 | .0035 | .0001 |

*The rains and snows of Mount Vernon, Iowa, 1936–37*—Continued

POUNDS PER ACRE—Continued
[226,875 pounds per acre=1 inch]

| No. | Date 1936-37 | Precipitation | | Chlorine | Free $NH_3$ | Alb. $NH_3$ | N in nitrate | N in nitrite | Sulphate |
|---|---|---|---|---|---|---|---|---|---|
| | | Amount | Kind | | | | | | |
| | | *Inches* | | | | | | | |
| 23 | Apr. 2 | 4.00 | Snow | 0.227 | 0.0082 | 0.0034 | 0.038 | 0.0015 | 0.0006 |
| 24 | Apr. 3 | 1.00 | Rain | 1.59 | .0308 | .1021 | .0908 | .0045 | .0020 |
| 25 | Apr. 5 | .80 | do | .22 | .017 | .014 | .028 | .0014 | .0005 |
| 26 | Apr. 7 | .25 | do | .20 | .023 | .026 | .0242 | .0010 | .0003 |
| 27 | Apr. 15 | .17 | do | .054 | .018 | .0076 | .0029 | .002 | .0002 |
| 28 | Apr. 21 | .80 | do | 1.278 | .0756 | .063 | .126 | .0072 | .0008 |
| 29 | Apr. 24 | .20 | do | .158 | .0158 | .0216 | .0338 | .0025 | .0005 |
| 30 | Apr. 25 | .15 | do | .136 | .0122 | .0068 | .017 | .0012 | .0002 |
| 31 | Apr. 28 | .20 | do | .13 | .006 | .02 | .0315 | .0024 | .0002 |
| 32 | Apr. 29 | .60 | do | .298 | .0336 | .0616 | .168 | .005 | .0001 |
| 33 | May 2 | 1.00 | do | .0322 | .0908 | .0726 | .00681 | .0091 | .0002 |
| 34 | May 3 | .30 | do | .079 | .0136 | .0272 | .0476 | .0019 | .00 |
| 35 | May 4 | .33 | do | .0567 | .0211 | .024 | .0302 | .0034 | .0008 |
| 36 | May 11 | .60 | do | .374 | .0435 | .0272 | .0952 | .0068 | .0009 |
| 37 | May 15 | .20 | do | .032 | .0145 | .011 | .036 | .0023 | .0002 |
| 38 | May 18 | .20 | do | .09 | .0158 | .0108 | .0495 | .0029 | .0003 |
| 39 | May 20 | .33 | do | .0684 | .0033 | .0319 | .0038 | .0037 | .0002 |
| 40 | May 27 | 1.25 | do | .1985 | .0386 | .0567 | .2141 | .021 | .0006 |
| 41 | June 2 | .17 | do | .1349 | .0152 | .01596 | .0258 | .0027 | .0001 |
| 42 | June 5 | .38 | do | .219 | .0262 | .0255 | .0474 | .0029 | .00008 |

## NOTES AND REVIEWS

HANN-SÜRING. *Lehrbuch der Meteorologie.* 5te Aufl. Erste Lieferung. Leipzig, 1937.

This initial section of a new edition of Hann comprises pages 1–96 inclusive, and covers roughly the same ground as pages 1–47 and 780–795 of the fourth edition, which was completed in 1926. Extensive changes from the previous edition have been made: The division of the material into parts, chapters, etc., has been altered; much of the material has been rearranged and rewritten; and many additions have been made. References to literature are now collected at the ends of the sections, instead of being given in footnotes.

The first section, on the atmosphere in general, was prepared by F. W. Paul Götz. It includes a summary of our present knowledge of the phenomena and physical conditions in the extreme upper atmosphere—chemical composition, ozone distribution, ionosphere, etc.

The second section is occupied with the subject of solar, sky, and terrestrial radiation, insolation, and atmospheric absorption and turbidity. The Lieferung also includes the opening part of the third section, on temperature, and contains the discussion of the mathematical treatment of periodic phenomena that was placed in VI. Buch in previous editions.—*Edgar W. Woolard.*

## BIBLIOGRAPHY

[RICHMOND T. ZOCH, *in Charge of Library*]

By AMY D. PUTNAM

### RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

**Alling, Jeremiah.**
A register of the weather, or An account of the several rains, snow-storms, depth of each snow,—hail and thunder . . . for the last twenty-five years, ending March 31, 1810. From observations, taken most of the time in Hamden, near New Haven, in Connecticut. New Haven. 1810. 84 p. 23½ cm. (Pages 81 to 84 carry register to March 1811.)

**Burkholder, Paul Rufus, & Johnston, Earl S.**
Inactivation of plant growth substance by light (with two plates). Wash., D. C. 1937. 14 p. illus., pls. 24½ cm. (Smithsonian miscellaneous collections. v. 95, no. 20.) Publication 3403. Running title: Growth substance. "Literature cited": p. 13–14.

**Clapp, Earle Hart.**
The major range problems and their solution. Résumé of a report prepared in response to Senate resolution 289, together with letters of transmittal, table of contents, etc. From "The Western range." By the Forest Service, U. S. Dept. of Agriculture. Wash., D. C. 1936. xvi, 69 p. maps. diagrs. 23 cm. ([U. S. 74th Cong., 2d sess.] Senate document no. 199. Separate no. 1.)

**Dedebant, Georges.**
Manuel de météorologie du pilote. Paris. [°1936.] 192 p. illus., pls., map, fold. charts, facsims., diagrs. form. 24½ cm. At head of title: G. Dedebant . . . A. Viaut.

**Gavett, George Irving.**
A first course in statistical method. 2d ed. New York & London. 1937. ix, 400 p. illus., tabs., diagrs. 23½ cm.

**Grangvist, Gunnar.**
Översigt av isarna vintern 1935/36, Helsingfors. 1936. 47 p. figs., tabs. 24½ cm. At head of title: [Finland.] Havsforskningsinstitutets skrift No. 108.

**Humphreys, William Jackson.**
Weather rambles. Baltimore. 1937. 265 p. illus., diagrs. 19½ cm.

**Ives, [James Edmund], & Sayers, Royd Ray.**
City smoke and its effects. A statement prepared for the congressional subcommittee on public health, hospitals, and charities. Wash., D. C. 1936. 4 p. tables. 23 cm. Reprint no. 1726 from the Public health reports, v. 51, no. 1, Jan. 3, 1936 (p. 15–18). Includes bibliographies.

**Petterssen, Sverre.**
Kinemathcal and dynamical properties of the field of pressure with application to weather forecasting. Oslo. 1933. 92 p. diagrs. 31 cm. (Geofysiske publikasjoner. v. x, no. 2.) Bibliography: p. 92.

**Størmer, Carl.**
Measuring of aurorae with very long base lines. With 16 figures in the text and 2 plates. Oslo. 1935. 15 p. illus. (map), tables, diagrs. (Geofysiske publikasjoner. v. xi, no. 3.) "Utgitt for midler av Fridtjof Nansens fond."

**Torok, Elmer.**
Air conditioning in the home; what air conditioning includes, its advantages, the fundamental principles of design, the installation and operation of air-conditioning systems, specific examples of heating and cooling calculations, designing data, and general information of importance both to engineers and home owners. 1st ed. New York & London. [°1937.] 296 p. illus., tabs., diagrs. 23½ cm.

# SOLAR OBSERVATIONS

## SOLAR RADIATION OBSERVATIONS DURING JULY 1937

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged above normal for July at Washington, and below normal at Madison and Lincoln. The values for Madison show markedly the effect of increasing contamination of the atmosphere with increasing factory activity.

Table 2 shows an excess in the amount of total solar and sky radiation received on a horizontal surface at all stations with the exception of Washington, Miami, and Riverside.

Owing to transmission tests now being made on the red and yellow filters used for turbidity studies, no component-radiation measurements were made at either Washington or Blue Hill during July.

Polarization measurements made at Madison on 12 days gives a mean of 60 percent with a maximum of 61 percent on the 27th. The average value is close to the corresponding normal for the month, but the maximum is slightly below the July normal.

*Recalibration of color screens in use at the Blue Hill Observatory.*—The desirability of a recalibration of the color screens in use at the Blue Hill Observatory, with the object of determining their possible departures from the mean transmissions of such screens as determined by Fuessner, has long been realized. Arrangements were therefore made, through the courtesy of I. F. Hand of the Weather Bureau, to have such tests conducted at the Bureau of Chemistry and Soils of the Department of Agriculture in Washington, and the screens were shipped on July 17.

Unexpected difficulties were encountered in making the calibrations, and the results have not been received in time to be used in computing values of $\beta$ and $w$ from screened readings obtained on July 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, and 16. The computation and publication of these results is therefore deferred, pending the completion of the determination of new transmission coefficients therefrom.—*H. H. K.*

TABLE 1.—*Solar radiation intensities during July 1937*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

| Date | Sun's zenith distance: 8 a. m. | 78.7° | 75.7° | 70.7° | 60.0° | 0.0° | 60.0° | 70.7° | 75.7° | 78.7° | Noon |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 75th mer. time | Air mass: A. M. | | | | [1] 1.0 | P. M. | | | | Local mean solar time |
| | e | 5.0 | 4.0 | 3.0 | 2.0 | | 2.0 | 3.0 | 4.0 | 5.0 | e |
| | *mm.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *mm.* |
| July 7 | 17.37 | ------ | 0.48 | 0.66 | 0.82 | 1.16 | ------ | ------ | ------ | ------ | 18.59 |
| July 12 | 17.96 | 0.71 | .78 | .87 | 1.18 | ------ | ------ | ------ | ------ | ------ | 19.23 |
| July 22 | 14.10 | ------ | ------ | 1.10 | 1.24 | 1.48 | ------ | ------ | ------ | ------ | 20.57 |
| July 23 | 16.20 | ------ | 1.03 | 1.16 | 1.27 | 1.49 | ------ | ------ | ------ | ------ | 13.61 |
| July 24 | 15.11 | ------ | .58 | 1.00 | 1.26 | 1.45 | ------ | ------ | ------ | ------ | 15.11 |
| Means | ------ | .71 | .72 | .96 | 1.13 | 1.40 | ------ | ------ | ------ | ------ | ------ |
| Departures | ------ | +.12 | +.04 | +.17 | +.20 | +.17 | ------ | ------ | ------ | ------ | ------ |

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during July 1937*—Contd.

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

| Date | Sun's zenith distance: 8 a. m. | 78.7° | 75.7° | 70.7° | 60.0° | 0.0° | 60.0° | 70.7° | 75.7° | 78.7° | Noon |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 75th mer. time | Air mass: A. M. | | | | [1] 1.0 | P. M. | | | | Local mean solar time |
| | e | 5.0 | 4.0 | 3.0 | 2.0 | | 2.0 | 3.0 | 4.0 | 5.0 | e |
| | *mm.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *mm.* |
| July 1 | 8.48 | ------ | ------ | ------ | ------ | 1.48 | ------ | ------ | ------ | ------ | 7.87 |
| July 6 | 14.60 | ------ | 0.65 | ------ | 1.00 | 1.34 | ------ | ------ | ------ | ------ | 14.10 |
| July 7 | 13.61 | ------ | ------ | ------ | 1.05 | 1.30 | ------ | ------ | ------ | ------ | 14.10 |
| July 9 | 15.65 | ------ | ------ | ------ | .63 | .88 | ------ | ------ | ------ | ------ | 16.79 |
| July 19 | 11.38 | ------ | .60 | ------ | .99 | 1.15 | ------ | ------ | ------ | ------ | 11.81 |
| July 20 | 8.81 | ------ | ------ | ------ | .83 | 1.10 | ------ | ------ | ------ | ------ | 9.83 |
| July 24 | 14.60 | ------ | .76 | 0.88 | 1.06 | ------ | ------ | ------ | ------ | ------ | 17.37 |
| July 26 | 8.48 | ------ | .95 | 1.01 | 1.30 | 1.47 | ------ | ------ | ------ | ------ | 7.57 |
| July 27 | 7.04 | 0.94 | 1.05 | 1.10 | 1.28 | 1.46 | ------ | ------ | ------ | ------ | 8.48 |
| July 28 | 12.68 | ------ | ------ | ------ | ------ | 1.30 | ------ | ------ | ------ | ------ | 9.47 |
| July 29 | 7.87 | ------ | ------ | .67 | .92 | 1.28 | ------ | ------ | ------ | ------ | 8.48 |
| July 30 | 10.21 | ------ | ------ | .70 | .92 | 1.24 | ------ | ------ | ------ | ------ | 11.38 |
| July 31 | 10.21 | ------ | ------ | .65 | .84 | 1.10 | ------ | ------ | ------ | ------ | 10.21 |
| Means | ------ | (.94) | .80 | .85 | .98 | 1.26 | ------ | ------ | ------ | ------ | ------ |
| Departures | ------ | +.26 | +.02 | −.07 | −.08 | −.04 | ------ | ------ | ------ | ------ | ------ |

LINCOLN, NEBR.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| July 2 | 9.83 | ------ | 0.95 | 1.08 | 1.27 | 1.45 | 1.11 | 0.92 | 0.76 | 0.66 | 9.14 |
| July 3 | 13.61 | 0.69 | .82 | .97 | 1.16 | 1.35 | ------ | ------ | ------ | ------ | 13.61 |
| July 6 | 12.68 | ------ | ------ | .92 | 1.08 | 1.29 | 1.02 | .85 | .70 | .59 | 13.13 |
| July 7 | 16.20 | .65 | .74 | .89 | 1.09 | 1.42 | ------ | ------ | ------ | ------ | 10.97 |
| July 9 | 15.65 | .47 | .58 | .75 | .95 | ------ | ------ | ------ | ------ | ------ | 11.81 |
| July 10 | 9.83 | ------ | .68 | .85 | ------ | ------ | ------ | ------ | ------ | ------ | 9.47 |
| July 14 | 16.20 | ------ | .75 | .90 | 1.11 | 1.30 | ------ | ------ | ------ | ------ | 17.37 |
| July 15 | 15.65 | .68 | .81 | .96 | 1.12 | ------ | 1.17 | .90 | .75 | .64 | 16.20 |
| July 16 | 14.10 | ------ | ------ | ------ | 1.06 | ------ | 1.09 | .90 | ------ | ------ | 11.38 |
| July 17 | 10.21 | ------ | ------ | ------ | 1.04 | 1.35 | ------ | ------ | ------ | ------ | 10.21 |
| July 21 | 16.20 | ------ | ------ | ------ | 1.18 | ------ | ------ | ------ | ------ | ------ | 12.68 |
| July 22 | 15.65 | .66 | .79 | .95 | 1.15 | 1.40 | 1.06 | .84 | ------ | ------ | 11.38 |
| July 26 | 10.97 | .64 | .81 | .91 | 1.05 | 1.41 | ------ | ------ | ------ | ------ | 11.38 |
| July 30 | 15.11 | ------ | .80 | .88 | 1.06 | 1.29 | ------ | ------ | ------ | ------ | 7.07 |
| Means | ------ | .63 | .77 | .91 | 1.10 | 1.36 | 1.09 | .88 | .74 | .63 | ------ |
| Departures | ------ | −.06 | −.02 | −.01 | +.01 | +.03 | +.02 | −.01 | −.02 | −.06 | ------ |

BLUE HILL, MASS.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| July 1 | 13.7 | ------ | ------ | ------ | ------ | 1.40 | 0.98 | ------ | ------ | ------ | 9.7 |
| July 2 | 9.6 | ------ | ------ | ------ | ------ | 1.22 | .98 | ------ | ------ | ------ | 9.9 |
| July 3 | 13.2 | ------ | ------ | ------ | ------ | 1.22 | .95 | ------ | ------ | ------ | 13.8 |
| July 4 | 13.2 | ------ | ------ | 0.73 | 0.93 | 1.19 | 1.06 | ------ | ------ | ------ | 13.0 |
| July 5 | 14.7 | ------ | ------ | ------ | 1.00 | 1.22 | .95 | ------ | ------ | ------ | 13.0 |
| July 6 | 12.8 | ------ | ------ | ------ | 1.22 | 1.22 | .96 | ------ | ------ | ------ | 13.3 |
| July 8 | 15.6 | ------ | ------ | ------ | ------ | 1.19 | ------ | ------ | ------ | ------ | 15.5 |
| July 9 | 18.8 | ------ | ------ | ------ | .84 | 1.00 | ------ | ------ | ------ | ------ | 15.5 |
| July 10 | 13.7 | ------ | ------ | ------ | .84 | 1.11 | .73 | ------ | ------ | ------ | 12.3 |
| July 11 | 15.3 | ------ | ------ | ------ | .78 | 1.08 | ------ | ------ | ------ | ------ | 10.4 |
| July 13 | 11.9 | ------ | ------ | ------ | ------ | 1.53 | 1.13 | ------ | ------ | ------ | 12.1 |
| July 14 | 10.3 | ------ | ------ | ------ | 1.22 | 1.42 | 1.11 | ------ | ------ | ------ | 9.6 |
| July 16 | 19.5 | ------ | ------ | ------ | ------ | 1.14 | 1.00 | 0.69 | ------ | ------ | 19.8 |
| July 17 | 11.9 | ------ | ------ | 1.07 | 1.11 | 1.34 | ------ | ------ | ------ | ------ | 18.5 |
| July 18 | 14.7 | ------ | ------ | 1.07 | 1.15 | 1.37 | ------ | ------ | ------ | ------ | 13.7 |
| July 20 | 13.7 | ------ | ------ | ------ | 1.00 | 1.32 | 1.08 | ------ | ------ | ------ | 11.5 |
| July 21 | 13.7 | ------ | ------ | ------ | ------ | 1.37 | 1.15 | 1.04 | 0.98 | .92 | 8.8 |
| July 22 | 11.9 | ------ | ------ | 1.03 | 1.19 | 1.38 | 1.08 | .94 | .89 | .85 | 9.7 |
| July 23 | 12.8 | ------ | ------ | .63 | .87 | 1.22 | .61 | .84 | .46 | .42 | 15.8 |
| July 24 | 14.7 | 0.37 | 0.46 | .53 | .60 | .98 | ------ | ------ | ------ | ------ | 15.9 |
| July 25 | 16.4 | ------ | .33 | .44 | .69 | .99 | ------ | ------ | ------ | ------ | 15.0 |
| July 26 | 19.5 | ------ | ------ | ------ | ------ | 1.20 | ------ | ------ | ------ | ------ | 19.1 |
| July 27 | 15.8 | ------ | ------ | ------ | ------ | 1.10 | ------ | ------ | ------ | ------ | 11.1 |
| July 28 | 10.3 | .90 | 1.02 | 1.09 | 1.21 | 1.41 | .72 | ------ | ------ | ------ | 9.6 |
| July 29 | 11.5 | ------ | ------ | .89 | 1.08 | 1.33 | 1.06 | .90 | ------ | ------ | 10.3 |
| July 30 | 15.3 | ------ | ------ | ------ | ------ | 1.19 | ------ | ------ | ------ | ------ | 11.5 |
| Means | ------ | (.64) | .60 | .91 | 1.05 | 1.26 | 1.01 | .91 | .82 | .74 | ------ |
| Departures | ------ | ------ | .00 | −.08 | −.07 | −.02 | −.04 | −.09 | −.04 | −.01 | ------ |

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

| Week beginning— | Washington | Madison | Lincoln | Chicago | New York | Fresno | Fairbanks | Twin Falls | La Jolla | Miami | New Orleans | Riverside | Blue Hill | San Juan | Friday Harbor | Ithaca | Newport |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gram-calories per square centimeter | | | | | | | | | | | | | | | | |
| 1937 | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. | cal. |
| July 2 | 476 | 659 | 713 | 518 | 471 | 744 | 427 | ------ | 531 | 457 | 444 | 576 | 586 | 690 | 602 | 583 | 575 |
| July 9 | 418 | 653 | 632 | 382 | 391 | 663 | 538 | 609 | 625 | 531 | 440 | 595 | 464 | 543 | 645 | 383 | 483 |
| July 16 | 459 | 666 | 666 | ------ | 492 | 691 | 396 | 621 | 451 | 543 | 477 | 528 | 561 | 658 | 648 | 517 | 558 |
| July 23 | 525 | 608 | 591 | 536 | 504 | 651 | 416 | 537 | 455 | 411 | 439 | 483 | 511 | 651 | 652 | 417 | 545 |
| | Departures from weekly normals | | | | | | | | | | | | | | | | |
| July 2 | −35 | +175 | +118 | +49 | +16 | +35 | −15 | ------ | ------ | −51 | +36 | −41 | +38 | ------ | +28 | +57 | ------ |
| July 9 | −75 | +17 | +44 | −71 | −58 | −31 | +46 | +8 | ------ | +6 | +39 | −5 | −64 | ------ | +70 | −132 | ------ |
| July 16 | −24 | +141 | +79 | ------ | +61 | +26 | −12 | +14 | ------ | +24 | +56 | −44 | +50 | ------ | +6 | +15 | ------ |
| July 23 | +35 | +95 | +35 | +68 | +74 | +9 | −15 | −31 | ------ | −74 | +64 | −56 | +5 | ------ | +37 | −61 | ------ |
| | Accumulated departures on July 29 | | | | | | | | | | | | | | | | |
| | −1,561 | +3,850 | +714 | +1,024 | −4,284 | +3,773 | +1589 | ------ | ------ | −6,244 | +6,671 | −3,416 | −686 | ------ | +140 | −3,539 | ------ |

## POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

| Date | Eastern standard time | Mount Wilson group number | Heliographic: Diff. in longitude | Heliographic: Longitude | Heliographic: Latitude | Area: Spot | Area: Group | Total area for each day | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| 1937 | h. m. | | ° | ° | ° | | | | |
| July 1 | 11 6 | 5433 | −62.0 | 292.5 | +15.0 | ------ | 97 | ------ | U. S. Naval. |
| | | 5431 | −5.0 | 349.5 | +16.0 | ------ | 242 | ------ | |
| | | 5430 | +23.0 | 17.5 | +17.5 | ------ | 73 | ------ | |
| | | 5423 | +46.0 | 40.5 | −17.0 | 194 | ------ | ------ | |
| | | 5419 | +61.0 | 55.5 | −11.0 | ------ | 194 | 800 | |
| July 2 | 11 9 | 5436 | −79.0 | 262.2 | +17.0 | 97 | ------ | ------ | Do. |
| | | 5435 | −62.0 | 279.2 | +12.0 | 6 | ------ | ------ | |
| | | 5433 | −50.0 | 291.2 | +14.0 | ------ | 48 | ------ | |
| | | 5434 | −24.5 | 316.7 | +10.5 | 24 | ------ | ------ | |
| | | 5432 | −16.0 | 325.2 | −14.0 | 24 | ------ | ------ | |
| | | 5431 | +10.0 | 351.2 | +16.0 | ------ | 436 | ------ | |
| | | 5423 | +59.0 | 40.2 | −17.5 | 145 | ------ | ------ | |
| | | 5419 | +74.0 | 55.2 | −12.0 | 145 | ------ | 925 | |
| July 3 | 10 26 | 5436 | −65.0 | 263.4 | +16.5 | 36 | ------ | ------ | Do. |
| | | 5435 | −48.0 | 280.4 | +12.0 | ------ | 48 | ------ | |
| | | 5433 | −38.5 | 289.9 | +14.0 | ------ | 48 | ------ | |
| | | 5437 | −29.0 | 299.4 | −19.0 | ------ | 24 | ------ | |
| | | 5431 | +23.0 | 351.4 | +16.0 | ------ | 582 | ------ | |
| | | 5423 | +70.0 | 38.4 | −17.5 | 194 | ------ | 932 | |
| July 4 | 10 44 | 5440 | −85.0 | 230.0 | −19.0 | ------ | 242 | ------ | Do. |
| | | 5436 | −52.0 | 263.0 | +16.5 | 36 | ------ | ------ | |
| | | 5435 | −34.0 | 281.0 | +11.0 | ------ | 97 | ------ | |
| | | 5439 | −31.5 | 283.5 | −10.0 | ------ | 24 | ------ | |
| | | 5433 | −24.5 | 290.5 | +14.0 | ------ | 73 | ------ | |
| | | 5437 | −14.0 | 301.0 | −19.0 | ------ | 48 | ------ | |
| | | 5431 | +36.0 | 351.0 | +16.0 | ------ | 485 | 1,005 | |
| July 5 | 11 47 | 5440 | −70.0 | 231.2 | −20.0 | ------ | 630 | ------ | Mt. Wilson. |
| | | 5436 | −40.0 | 261.2 | +17.0 | 48 | ------ | ------ | |
| | | 5435 | −21.0 | 280.2 | +12.0 | ------ | 291 | ------ | |
| | | 5439 | −16.0 | 285.2 | −10.5 | ------ | 12 | ------ | |
| | | 5433 | −9.5 | 291.7 | +14.0 | 12 | ------ | ------ | |
| | | 5437 | +1.0 | 302.2 | −19.0 | ------ | 48 | ------ | |
| | | 5431 | +50.0 | 351.2 | +17.0 | ------ | 455 | 1,526 | |
| July 6 | 13 52 | 5445 | −81.0 | 205.8 | −9.0 | 194 | ------ | ------ | U. S. Naval. |
| | | 5444 | −78.0 | 208.8 | +10.0 | 388 | ------ | ------ | |
| | | 5440 | −56.0 | 230.8 | −20.0 | ------ | 776 | ------ | |
| | | 5441 | −31.0 | 255.8 | +22.0 | ------ | 145 | ------ | |
| | | 5436 | −26.0 | 260.8 | +17.5 | 36 | ------ | ------ | |
| | | 5435 | −6.0 | 280.8 | +12.0 | ------ | 388 | ------ | |
| | | 5437 | +18.0 | 304.8 | −19.0 | ------ | 36 | ------ | |
| | | 5443 | +31.0 | 317.8 | +12.0 | ------ | 12 | ------ | |
| | | 5442 | +35.0 | 321.8 | −9.0 | ------ | 48 | ------ | |
| | | 5431 | +63.0 | 349.8 | +17.0 | ------ | 533 | 2,556 | |
| July 7 | 11 15 | 5447 | −85.0 | 190.0 | +15.5 | 194 | ------ | ------ | Do. |
| | | 5446 | −79.0 | 196.0 | −15.0 | 97 | ------ | ------ | |
| | | 5445 | −68.0 | 207.0 | −8.0 | 97 | ------ | ------ | |
| | | 5444 | −65.0 | 210.0 | +10.5 | 388 | ------ | ------ | |
| | | 5440 | −45.0 | 230.0 | −19.0 | ------ | 582 | ------ | |
| | | 5441 | −19.0 | 256.0 | +23.0 | ------ | 485 | ------ | |
| | | 5436 | −14.0 | 261.0 | +18.0 | 36 | ------ | ------ | |
| | | 5435 | +7.0 | 282.0 | +12.5 | ------ | 485 | ------ | |
| | | 5437 | +28.0 | 303.0 | −18.0 | ------ | 145 | ------ | |
| | | 5431 | +74.0 | 349.0 | +17.0 | ------ | 388 | 2,897 | |

## POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mount Wilson group number | Heliographic: Diff. in longitude | Heliographic: Longitude | Heliographic: Latitude | Area: Spot | Area: Group | Total area for each day | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| 1937 | h. m. | | ° | ° | ° | | | | |
| July 8 | 11 7 | 5454 | −81.0 | 180.8 | −10.5 | 218 | ------ | ------ | U. S. Naval. |
| | | 5453 | −79.0 | 182.8 | +11.0 | ------ | 24 | ------ | |
| | | 5452 | −75.0 | 186.8 | −11.0 | ------ | 436 | ------ | |
| | | 5447 | −70.5 | 191.3 | +15.0 | 242 | ------ | ------ | |
| | | 5446 | −66.0 | 195.8 | −15.0 | ------ | 242 | ------ | |
| | | 5445 | −56.0 | 205.8 | −8.5 | 97 | ------ | ------ | |
| | | 5450 | −56.0 | 205.8 | +9.0 | ------ | 48 | ------ | |
| | | 5444 | −50.5 | 211.3 | +10.0 | 339 | ------ | ------ | |
| | | 5440 | −31.0 | 230.8 | −19.5 | ------ | 533 | ------ | |
| | | 5441 | −7.0 | 254.8 | +23.0 | ------ | 582 | ------ | |
| | | 5441 | −2.0 | 259.8 | +21.5 | 436 | ------ | ------ | |
| | | 5436 | −1.0 | 260.8 | +18.5 | 24 | ------ | ------ | |
| | | 5449 | +5.0 | 266.8 | +12.0 | ------ | 24 | ------ | |
| | | 5435 | +19.0 | 280.8 | +12.5 | ------ | 582 | ------ | |
| | | 5437 | +40.0 | 301.8 | −19.0 | ------ | 218 | 4045 | |
| July 9 | 12 1 | 5455 | −79.0 | 169.1 | −16.0 | ------ | 679 | ------ | Do. |
| | | 5453 | −68.0 | 180.1 | +13.0 | ------ | 194 | ------ | |
| | | 5454 | −64.0 | 184.1 | −10.0 | 291 | ------ | ------ | |
| | | 5452 | −61.0 | 187.1 | −10.0 | ------ | 339 | ------ | |
| | | 5447 | −58.0 | 190.1 | +15.0 | 242 | ------ | ------ | |
| | | 5446 | −50.0 | 198.1 | −14.0 | ------ | 170 | ------ | |
| | | 5451 | −41.0 | 207.1 | −14.0 | ------ | 36 | ------ | |
| | | 5445 | −40.5 | 207.6 | −8.0 | 145 | ------ | ------ | |
| | | 5450 | −40.5 | 207.6 | +9.5 | ------ | 121 | ------ | |
| | | 5444 | −38.0 | 210.1 | +10.5 | 291 | ------ | ------ | |
| | | 5440 | −18.0 | 230.1 | −19.5 | ------ | 436 | ------ | |
| | | 5441 | −6.0 | 242.1 | +23.0 | ------ | 679 | ------ | |
| | | 5436 | +11.5 | 259.6 | +19.0 | 24 | ------ | ------ | |
| | | 5441 | +12.5 | 260.6 | +21.5 | 533 | ------ | ------ | |
| | | 5449 | +20.0 | 268.1 | +13.0 | ------ | 12 | ------ | |
| | | 5435 | +32.0 | 280.1 | +13.0 | ------ | 436 | ------ | |
| | | 5437 | +55.0 | 303.1 | −19.5 | ------ | 170 | 4,798 | |
| July 10 | 11 2 | 5456 | −76.0 | 159.4 | +25.0 | 97 | ------ | ------ | Do. |
| | | 5455 | −69.0 | 166.4 | −16.5 | ------ | 485 | ------ | |
| | | 5453 | −53.0 | 182.4 | +14.0 | ------ | 339 | ------ | |
| | | 5454 | −51.0 | 184.4 | −10.5 | 291 | ------ | ------ | |
| | | 5459 | −49.0 | 186.4 | +20.5 | ------ | 24 | ------ | |
| | | 5452 | −48.0 | 187.4 | −10.0 | ------ | 291 | ------ | |
| | | 5447 | −43.0 | 192.4 | +15.0 | 339 | ------ | ------ | |
| | | 5446 | −38.0 | 197.4 | −14.0 | 194 | ------ | ------ | |
| | | 5445 | −28.5 | 206.9 | −8.0 | 121 | ------ | ------ | |
| | | 5451 | −28.5 | 206.9 | −12.5 | ------ | 97 | ------ | |
| | | 5450 | −28.0 | 207.4 | +9.5 | ------ | 388 | ------ | |
| | | 5444 | −24.0 | 211.4 | +10.5 | 291 | ------ | ------ | |
| | | 5440 | −5.0 | 230.4 | −19.0 | ------ | 412 | ------ | |
| | | 5458 | +0.5 | 235.9 | +10.5 | ------ | 24 | ------ | |
| | | 5441 | +21.0 | 256.4 | +23.0 | ------ | 1600 | ------ | |
| | | 5457 | +21.0 | 256.4 | −30.0 | ------ | 24 | ------ | |
| | | 5436 | +25.0 | 260.4 | +19.0 | 24 | ------ | ------ | |
| | | 5435 | +47.0 | 282.4 | +13.0 | ------ | 388 | ------ | |
| | | 5437 | +69.0 | 304.4 | −20.0 | ------ | 291 | 5,720 | |
| July 11 | 12 3 | 5460 | −69.0 | 152.6 | +30.0 | 24 | ------ | ------ | Do. |
| | | 5456 | −63.0 | 158.6 | +26.0 | ------ | 73 | ------ | |
| | | 5455 | −55.0 | 166.6 | −17.0 | ------ | 436 | ------ | |
| | | 5454 | −38.0 | 183.6 | −11.0 | 218 | ------ | ------ | |
| | | 5453 | −38.0 | 183.6 | +13.0 | ------ | 242 | ------ | |
| | | 5452 | −33.0 | 188.6 | −12.0 | ------ | 194 | ------ | |
| | | 5459 | −33.0 | 188.6 | +20.0 | ------ | 24 | ------ | |
| | | 5447 | −29.0 | 192.6 | +14.0 | 315 | ------ | ------ | |
| | | 5446 | −23.0 | 198.6 | −14.5 | 194 | ------ | ------ | |
| | | 5450 | −15.0 | 206.6 | +9.0 | ------ | 436 | ------ | |
| | | 5445 | −13.0 | 208.6 | −9.0 | 97 | ------ | ------ | |
| | | 5451 | −13.0 | 208.6 | −13.6 | ------ | 48 | ------ | |
| | | 5444 | −11.0 | 210.6 | +10.5 | 291 | ------ | ------ | |

## POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mount Wilson group number | Heliographic: Diff. in longitude | Heliographic: Longitude | Heliographic: Latitude | Area: Spot | Area: Group | Total area for each day | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| *1937* | h. m. | | ° | ° | ° | | | | |
| July 11 | 12 3 | 5440 | +8.0 | 229.6 | −19.5 | | 412 | | U. S. Naval. |
| | | 5462 | +10.5 | 232.1 | −31.0 | | 12 | | |
| | | 5457 | +33.0 | 254.6 | −30.0 | | 24 | | |
| | | 5441 | +34.0 | 255.6 | +23.0 | | 1406 | | |
| | | 5436 | +39.0 | 260.6 | +19.0 | 12 | | | |
| | | 5461 | +63.0 | 284.6 | −12.5 | 48 | | | |
| | | 5435 | +64.0 | 285.6 | +13.0 | | 339 | | |
| | | 5437 | +80.0 | 301.6 | −20.0 | 97 | | 4,942 | |
| July 12 | 10 59 | 5464 | −86.0 | 123.0 | +19.0 | 97 | | | Do. |
| | | 5463 | −80.0 | 129.0 | +12.0 | | 242 | | |
| | | 5456 | −51.0 | 158.0 | +25.5 | | 73 | | |
| | | 5455 | −41.0 | 168.0 | −17.0 | | 291 | | |
| | | 5454 | −26.0 | 183.0 | −11.0 | | 194 | | |
| | | 5453 | −25.0 | 184.0 | +13.0 | | 145 | | |
| | | 5452 | −19.0 | 190.0 | −12.0 | | 145 | | |
| | | 5459 | −19.0 | 190.0 | +19.0 | | 12 | | |
| | | 5447 | −16.0 | 193.0 | +13.5 | 267 | | | |
| | | 5446 | −11.0 | 198.0 | −15.0 | 145 | | | |
| | | 5450 | −1.0 | 208.0 | +8.0 | | 436 | | |
| | | 5451 | 0.0 | 209.0 | −13.0 | | 24 | | |
| | | 5445 | 0.0 | 209.0 | −8.0 | 73 | | | |
| | | 5444 | +1.5 | 210.5 | +10.5 | 315 | | | |
| | | 5440 | +21.0 | 230.0 | −19.5 | | 412 | | |
| | | 5458 | +26.0 | 235.0 | +11.0 | 12 | | | |
| | | 5441 | +47.0 | 256.0 | +23.0 | | 1406 | | |
| | | 5457 | +50.0 | 259.0 | −28.5 | | 24 | | |
| | | 5436 | +51.0 | 260.0 | +18.5 | 6 | | | |
| | | 5435 | +80.0 | 289.0 | +11.0 | | 242 | | |
| | | 5461 | +80.0 | 289.0 | −13.0 | 97 | | 4,658 | |
| July 13 | 11 3 | 5467 | −85.0 | 110.7 | +15.0 | 194 | | | Do. |
| | | 5465 | −80.0 | 115.7 | −15.0 | | 339 | | |
| | | 5466 | −80.0 | 115.7 | +11.0 | 485 | | | |
| | | 5464 | −70.5 | 125.2 | +20.0 | 97 | | | |
| | | 5463 | −69.0 | 126.7 | +12.5 | | 436 | | |
| | | 5456 | −37.0 | 158.7 | +25.0 | | 36 | | |
| | | 5455 | −25.0 | 170.7 | −17.0 | | 291 | | |
| | | 5454 | −11.5 | 184.2 | −11.0 | 194 | | | |
| | | 5453 | −11.0 | 184.7 | +13.0 | | 145 | | |
| | | 5452 | −4.5 | 191.2 | −12.0 | | 145 | | |
| | | 5447 | −2.0 | 193.7 | +12.0 | 267 | | | |
| | | 5446 | +2.0 | 197.7 | −16.0 | 121 | | | |
| | | 5451 | +11.0 | 206.7 | −15.0 | | 24 | | |
| | | 5445 | +13.0 | 208.7 | −9.5 | 61 | | | |
| | | 5450 | +13.0 | 208.7 | +8.0 | | 485 | | |
| | | 5444 | +15.0 | 210.7 | +10.0 | 315 | | | |
| | | 5440 | +35.0 | 230.7 | −20.0 | | 412 | | |
| | | 5457 | +38.0 | 233.7 | −31.0 | | 24 | | |
| | | 5441 | +59.0 | 254.7 | +23.0 | | 1,309 | | |
| | | 5462 | +61.0 | 256.7 | −30.0 | | 48 | 5,428 | |
| July 14 | 8 47 | 5469 | −82.0 | 101.7 | −22.0 | 145 | | | Mt. Wilson. |
| | | 5467 | −74.0 | 109.7 | +16.0 | 242 | | | |
| | | 5465 | −69.0 | 114.7 | −16.0 | | 339 | | |
| | | 5466 | −67.0 | 116.7 | +12.0 | | 194 | | |
| | | 5463 | −60.0 | 123.7 | +12.5 | | 485 | | |
| | | 5464 | −59.0 | 124.7 | +20.5 | 121 | | | |
| | | 5456 | −24.0 | 159.7 | +25.0 | | 24 | | |
| | | 5455 | −11.0 | 172.7 | −16.0 | | 194 | | |
| | | 5454 | +2.0 | 185.7 | −11.0 | 194 | | | |
| | | 5453 | +4.0 | 187.7 | +13.0 | | 97 | | |
| | | 5468 | +7.0 | 190.7 | −12.0 | | 48 | | |
| | | 5452 | +8.0 | 191.7 | −13.0 | 73 | | | |
| | | 5447 | +10.5 | 194.2 | +13.0 | 194 | | | |
| | | 5446 | +16.0 | 199.7 | −16.0 | 97 | | | |
| | | 5451 | +25.0 | 208.7 | −16.0 | | 24 | | |
| | | 5445 | +28.0 | 211.7 | −9.5 | 36 | | | |
| | | 5450 | +28.0 | 211.7 | +9.0 | | 436 | | |
| | | 5444 | +29.5 | 213.2 | +11.0 | 242 | | | |
| | | 5440 | +54.0 | 237.7 | −19.0 | | 388 | | |
| | | 5462 | +56.0 | 237.7 | −31.0 | 6 | | | |
| | | 5457 | +70.0 | 253.7 | −30.0 | | 48 | | |
| | | 5441 | +75.0 | 258.7 | +24.0 | | 1,309 | 4,936 | |
| July 15 | 11 25 | 5469 | −67.0 | 102.1 | −22.0 | 121 | | | U. S. Naval. |
| | | 5467 | −59.0 | 110.1 | +14.0 | 194 | | | |
| | | 5465 | −54.0 | 115.1 | −16.0 | | 242 | | |
| | | 5466 | −51.0 | 118.1 | +10.0 | | 218 | | |
| | | 5464 | −44.0 | 125.1 | +20.0 | 145 | | | |
| | | 5463 | −41.0 | 128.1 | +12.0 | | 582 | | |
| | | 5455 | +1.0 | 170.1 | −17.0 | | 97 | | |
| | | 5454 | +17.0 | 186.1 | −10.5 | 194 | | | |
| | | 5453 | +18.0 | 187.1 | +13.0 | | 97 | | |
| | | 5468 | +20.0 | 189.1 | −12.0 | | 73 | | |
| | | 5447 | +24.5 | 193.6 | +13.0 | 170 | | | |
| | | 5446 | +30.0 | 199.1 | −15.0 | 73 | | | |
| | | 5450 | +40.0 | 209.1 | +9.5 | | 436 | | |
| | | 5444 | +41.0 | 210.1 | +10.0 | 218 | | | |
| | | 5440 | +65.0 | 234.1 | −19.5 | 291 | | | |
| | | 5462 | +69.0 | 238.1 | −21.5 | 97 | | | |
| | | 5441 | +84.0 | 253.1 | +24.0 | | 485 | 3,733 | |
| July 16 | 10 38 | 5469 | −53.5 | 102.8 | −22.0 | 97 | | | Do. |
| | | 5467 | −45.5 | 110.8 | +14.5 | | 97 | | |
| | | 5465 | −40.0 | 116.3 | −15.5 | | 194 | | |
| | | 5466 | −37.0 | 119.3 | +10.5 | | 145 | | |
| | | 5463 | −31.0 | 125.3 | +11.0 | | 170 | | |
| | | 5464 | −30.5 | 125.8 | +20.0 | 73 | | | |
| | | 5463 | −26.0 | 130.3 | +12.5 | | 485 | | |

## POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mount Wilson group number | Heliographic: Diff. in longitude | Heliographic: Longitude | Heliographic: Latitude | Area: Spot | Area: Group | Total area for each day | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| *1937* | h. m. | | ° | ° | ° | | | | |
| July 16 | 10 38 | 5455 | +17.0 | 173.3 | −15.5 | | 61 | | U. S. Naval. |
| | | 5454 | +29.0 | 185.3 | −9.5 | 145 | | | |
| | | 5468 | +30.0 | 186.3 | −11.0 | | 291 | | |
| | | 5453 | +31.0 | 187.3 | +12.0 | 48 | | | |
| | | 5447 | +38.0 | 194.3 | +13.0 | 97 | | | |
| | | 5446 | +41.0 | 197.3 | −13.0 | 48 | | | |
| | | 5450 | +53.0 | 209.3 | +9.5 | | 339 | | |
| | | 5444 | +53.0 | 209.3 | +10.5 | 194 | | | |
| | | 5440 | +79.0 | 235.3 | −19.0 | | 194 | 2,678 | |
| July 17 | 11 1 | 5472 | −79.0 | 63.8 | −13.5 | | 388 | | Do. |
| | | 5471 | −75.0 | 67.8 | +5.5 | 145 | | | |
| | | 5469 | −40.0 | 102.8 | −22.0 | 97 | | | |
| | | 5467 | −33.0 | 109.8 | +14.0 | 109 | | | |
| | | 5465 | −27.0 | 115.8 | −15.0 | | 218 | | |
| | | 5466 | −25.0 | 117.8 | +11.0 | | 145 | | |
| | | 5464 | −19.0 | 123.8 | +20.0 | 97 | | | |
| | | 5463 | −12.0 | 130.8 | +13.0 | | 679 | | |
| | | 5455 | +30.0 | 172.8 | −15.0 | 48 | | | |
| | | 5454 | +41.0 | 183.8 | −9.5 | 121 | | | |
| | | 5468 | +43.0 | 185.8 | −12.0 | | 242 | | |
| | | 5453 | +45.0 | 187.8 | +13.0 | 48 | | | |
| | | 5447 | +51.0 | 193.8 | +13.5 | 97 | | | |
| | | 5446 | +56.0 | 198.8 | −14.0 | 48 | | | |
| | | 5444 | +66.0 | 208.8 | +10.5 | 121 | | | |
| | | 5450 | +67.0 | 209.8 | +10.0 | | 242 | 2,485 | |
| July 18 | 13 45 | 5473 | −71.0 | 57.1 | −20.0 | | 48 | | Do. |
| | | 5472 | −65.0 | 63.1 | −14.5 | | 485 | | |
| | | 5471 | −59.5 | 68.6 | +6.0 | 121 | | | |
| | | 5469 | −26.5 | 101.6 | −22.0 | 97 | | | |
| | | 5467 | −18.0 | 110.1 | +14.0 | 97 | | | |
| | | 5465 | −11.0 | 117.1 | −16.0 | | 121 | | |
| | | 5466 | −10.0 | 118.1 | +11.0 | | 97 | | |
| | | 5464 | −3.0 | 125.1 | +20.0 | 97 | | | |
| | | 5463 | +1.0 | 129.1 | +13.0 | | 970 | | |
| | | 5455 | +44.0 | 172.1 | −15.0 | 24 | | | |
| | | 5454 | +57.0 | 185.1 | −9.5 | 121 | | | |
| | | 5468 | +58.0 | 186.1 | −11.0 | | 194 | | |
| | | 5453 | +61.0 | 189.1 | +13.0 | 36 | | | |
| | | 5470 | +67.0 | 195.1 | +9.0 | 36 | | | |
| | | 5447 | +69.0 | 197.1 | +14.0 | 97 | | | |
| | | 5450 | +78.0 | 206.1 | +10.5 | 194 | | | |
| | | 5444 | +80.0 | 208.1 | +10.5 | 242 | | 3,077 | |
| July 19 | 11 18 | 5474 | −70.0 | 46.2 | −22.0 | | 145 | | Do. |
| | | 5473 | −60.0 | 56.2 | −20.0 | 24 | | | |
| | | 5472 | −53.0 | 63.2 | −14.5 | | 630 | | |
| | | 5471 | −46.0 | 70.2 | +6.5 | 97 | | | |
| | | 5469 | −14.0 | 102.2 | −22.0 | 97 | | | |
| | | 5467 | −6.0 | 110.2 | +14.0 | 97 | | | |
| | | 5466 | +1.0 | 117.2 | +11.0 | 48 | | | |
| | | 5465 | +2.0 | 118.2 | −16.0 | | 48 | | |
| | | 5464 | +7.5 | 123.7 | +19.5 | | 145 | | |
| | | 5463 | +14.5 | 130.7 | +13.0 | | 824 | | |
| | | 5455 | +58.0 | 174.2 | −16.0 | 24 | | | |
| | | 5454 | +70.0 | 186.2 | −10.5 | 73 | | | |
| | | 5468 | +71.0 | 187.2 | −12.0 | | 145 | | |
| | | 5447 | +79.0 | 195.2 | +12.5 | 97 | | 2,494 | |
| July 20 | 10 53 | 5474 | −56.0 | 47.2 | −21.0 | | 145 | | Mt. Wilson. |
| | | 5473 | −46.0 | 57.2 | −19.5 | 12 | | | |
| | | 5472 | −38.0 | 65.2 | −14.0 | | 630 | | |
| | | 5471 | −31.5 | 71.7 | +7.0 | | 73 | | |
| | | 5475 | −22.0 | 81.2 | −23.0 | | 24 | | |
| | | 5469 | 0.0 | 103.2 | −22.0 | 97 | | | |
| | | 5467 | +11.0 | 114.2 | +15.0 | 73 | | | |
| | | 5466 | +16.0 | 119.2 | +12.0 | 48 | | | |
| | | 5465 | +19.5 | 122.7 | −15.0 | | 36 | | |
| | | 5464 | +23.0 | 126.2 | +20.5 | | 194 | | |
| | | 5463 | +30.0 | 133.2 | +13.0 | | 776 | | |
| | | 5455 | +71.0 | 174.2 | −16.0 | 18 | | | |
| | | 5454 | +86.0 | 189.2 | −10.0 | 48 | | 2,174 | |
| July 21 | 10 53 | 5477 | −87.0 | 3.0 | +29.0 | 145 | | | U. S. Naval. |
| | | 5474 | −45.0 | 45.0 | −21.0 | | 97 | | |
| | | 5476 | −32.0 | 58.0 | +11.0 | | 48 | | |
| | | 5473 | −31.5 | 58.5 | −19.0 | 12 | | | |
| | | 5472 | −26.0 | 64.0 | −13.0 | | 630 | | |
| | | 5471 | −20.0 | 70.0 | +8.0 | 61 | | | |
| | | 5475 | −9.0 | 81.0 | −23.0 | | 48 | | |
| | | 5469 | +11.0 | 101.0 | −12.0 | 97 | | | |
| | | 5467 | +21.0 | 111.0 | +14.0 | 73 | | | |
| | | 5466 | +27.0 | 117.0 | +11.0 | 36 | | | |
| | | 5465 | +30.0 | 120.0 | −14.0 | | 12 | | |
| | | 5464 | +33.0 | 128.0 | +19.5 | | 121 | | |
| | | 5463 | +42.0 | 132.0 | +12.5 | | 727 | 2,107 | |
| July 22 | 10 59 | 5477 | −78.0 | 358.7 | +29.5 | | 1212 | | Do. |
| | | 5474 | −31.0 | 45.7 | −21.5 | | 48 | | |
| | | 5473 | −19.0 | 57.7 | −19.5 | 12 | | | |
| | | 5476 | −17.0 | 59.7 | +10.0 | | 48 | | |
| | | 5472 | −13.0 | 63.7 | −14.0 | | 679 | | |
| | | 5471 | −6.0 | 70.7 | +7.5 | 36 | | | |
| | | 5475 | +3.0 | 79.7 | −22.0 | | 48 | | |
| | | 5469 | +25.0 | 101.7 | −21.0 | 145 | | | |
| | | 5467 | +35.0 | 111.7 | +14.0 | 61 | | | |
| | | 5466 | +39.0 | 115.7 | +10.0 | | 48 | | |
| | | 5465 | +43.0 | 119.7 | −14.0 | | 12 | | |
| | | 5464 | +46.0 | 122.7 | +20.0 | | 97 | | |
| | | 5463 | +54.0 | 130.7 | +13.0 | | 630 | 3,076 | |

POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mount Wilson group number | Heliographic: Diff. in longitude | Heliographic: Longitude | Heliographic: Latitude | Area: Spot | Area: Group | Total area for each day | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| 1937 | h. m. | | ° | ° | ° | | | | |
| July 23 | 11 12 | 5477 | −64.0 | 359.3 | +30.0 | | 1309 | | U. S. Naval. |
| | | 5474 | −19.0 | 44.3 | −21.0 | 36 | | | |
| | | 5476 | −5.0 | 58.3 | +10.5 | | 97 | | |
| | | 5472 | +1.0 | 64.3 | −14.0 | | 482 | | |
| | | 5471 | +8.5 | 71.8 | +7.5 | 24 | | | |
| | | 5469 | +39.0 | 102.3 | −21.0 | 97 | | | |
| | | 5467 | +48.0 | 111.3 | +14.0 | 36 | | | |
| | | 5465 | +59.0 | 122.3 | −15.0 | | 36 | | |
| | | 5463 | +69.0 | 132.3 | +13.0 | | 533 | 2,750 | |
| July 24 | 11 11 | 5477 | −51.0 | 359.1 | +30.5 | | 1503 | | |
| | | 5476 | +9.0 | 59.1 | +10.0 | | 121 | | Do. |
| | | 5472 | +13.0 | 63.1 | −14.5 | | 485 | | |
| | | 5471 | +21.0 | 71.1 | +7.5 | 12 | | | |
| | | 5469 | +51.0 | 101.1 | −21.0 | 97 | | | |
| | | 5463 | +85.0 | 135.1 | +12.0 | | 533 | 2,751 | |
| July 25 | 13 32 | 5477 | −37.5 | 358.1 | +30.5 | | 2182 | | Do. |
| | | 5479 | −17.5 | 18.1 | +15.5 | | 24 | | |
| | | 5478 | +21.0 | 56.6 | −19.0 | 16 | | | |
| | | 5476 | +24.0 | 59.6 | +9.5 | | 242 | | |
| | | 5472 | +28.0 | 63.6 | −15.0 | | 485 | | |
| | | 5469 | +65.0 | 100.6 | −21.0 | 97 | | 3,046 | |
| July 26 | 12 20 | 5481 | −82.0 | 300.9 | +29.5 | 242 | | | Do. |
| | | 5477 | −25.0 | 357.9 | +31.0 | | 2763 | | |
| | | 5479 | −4.0 | 18.9 | +15.0 | | 48 | | |
| | | 5478 | +35.0 | 57.9 | −18.5 | 6 | | | |
| | | 5476 | +38.5 | 61.4 | +9.5 | | 194 | | |
| | | 5472 | +41.0 | 63.9 | −14.0 | | 679 | | |
| | | 5469 | +79.0 | 101.9 | −21.0 | 97 | | 4,029 | |
| July 27 | 11 13 | 5483 | −79.0 | 291.4 | −12.0 | | 291 | | Do. |
| | | 5481 | −70.0 | 300.4 | +29.0 | 194 | | | |
| | | 5477 | −13.0 | 357.4 | +31.0 | | 2763 | | |
| | | 5479 | +9.0 | 19.4 | +15.0 | | 36 | | |
| | | 5476 | +51.0 | 61.4 | +9.0 | | 242 | | |
| | | 5472 | +55.0 | 65.4 | −15.0 | | 679 | 4,205 | |
| July 28 | 11 7 | 5484 | −68.0 | 289.2 | +7.0 | 24 | | | Do. |
| | | 5483 | −65.0 | 292.2 | −12.0 | | 388 | | |
| | | 5481 | −59.0 | 298.2 | +29.0 | 194 | | | |
| | | 5485 | −54.0 | 303.2 | −22.0 | | 24 | | |
| | | 5477 | −1.0 | 356.2 | +33.0 | | 2521 | | |
| | | 5479 | +22.5 | 19.7 | +15.0 | | 36 | | |
| | | 5476 | +65.0 | 62.2 | +10.0 | | 194 | | |
| | | 5472 | +68.0 | 65.2 | −15.0 | | 533 | 3,914 | |
| July 29 | 11 26 | 5486 | −70.0 | 273.8 | −17.0 | | 145 | | Do. |
| | | 5484 | −53.0 | 290.8 | +7.0 | 6 | | | |
| | | 5483 | −52.0 | 291.8 | −11.0 | | 533 | | |
| | | 5481 | −46.0 | 297.8 | +29.0 | 242 | | | |
| | | 5485 | −39.0 | 304.8 | −21.0 | | 97 | | |
| | | 5477 | +3.0 | 346.8 | +34.0 | | 1406 | | |
| | | 5477 | +19.5 | 3.3 | +29.0 | | 1115 | | |
| | | 5479 | +40.0 | 23.8 | +14.0 | 12 | | | |
| | | 5476 | +74.0 | 57.8 | +9.0 | 194 | | | |
| | | 5472 | +79.0 | 62.8 | −15.0 | | 485 | 4,235 | |
| July 30 | 11 6 | 5489 | −80.0 | 250.8 | +24.0 | | 970 | | Do. |
| | | 5487 | −56.0 | 274.8 | +15.0 | 16 | | | |
| | | 5486 | −55.5 | 275.3 | −15.5 | | 73 | | |

POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mount Wilson group number | Heliographic: Diff. in longitude | Heliographic: Longitude | Heliographic: Latitude | Area: Spot | Area: Group | Total area for each day | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| 1937 | h. m. | | ° | ° | ° | | | | |
| July 30 | 11 6 | 5484 | −39.5 | 291.3 | +8.5 | 24 | | | |
| | | 5483 | −38.0 | 292.8 | −11.0 | | 388 | | |
| | | 5481 | −34.0 | 296.8 | +30.0 | 194 | | | |
| | | 5485 | −28.0 | 302.8 | −21.0 | | 73 | | |
| | | 5477 | +16.0 | 346.8 | +33.5 | | 1406 | | |
| | | 5477 | +34.0 | 4.8 | +29.5 | | 1067 | | |
| | | 5479 | +54.0 | 241.8 | +14.0 | 16 | | 4,227 | |
| July 31 | 13 6 | 5489 | −66.0 | 250.5 | +23.0 | | 1454 | | U. S. Naval. |
| | | 5488 | −64.0 | 252.5 | +30.0 | 194 | | | |
| | | 5487 | −42.0 | 274.5 | +15.0 | | 73 | | |
| | | 5486 | −41.0 | 275.5 | −14.0 | | 85 | | |
| | | 5484 | −25.0 | 291.5 | +8.0 | 48 | | | |
| | | 5483 | −23.0 | 294.5 | −11.0 | | 388 | | |
| | | 5481 | −20.0 | 296.5 | +30.0 | 194 | | | |
| | | 5485 | −11.0 | 305.5 | −21.0 | | 73 | | |
| | | 5477 | +29.5 | 346.0 | +34.0 | | 1309 | | |
| | | 5477 | +48.0 | 4.5 | +29.5 | | 970 | 4,788 | |

Mean daily area for 31 days, 3,256.

## PROVISIONAL SUNSPOT RELATIVE NUMBERS, JULY 1937

[Dependent along on observations at Zurich and its station at Arosa]

[Furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

| July 1937 | Relative numbers | July 1937 | Relative numbers | July 1937 | Relative numbers |
|---|---|---|---|---|---|
| 1 | *a* 69 | 11 | *Wac* 202 | 21 | 150 |
| 2 | *Ec* 91 | 12 | *ad* 223 | 22 | *d* 145 |
| 3 | 74 | 13 | *a* 188 | 23 | *a* 139 |
| 4 | *Mcd* 65 | 14 | *aad* 215 | 24 | 126 |
| 5 | 91 | 15 | *a* 204 | 25 | 124 |
| 6 | *Ecd* 108 | 16 | | 26 | *d* 115 |
| 7 | *a* 143 | 17 | *d* 152 | 27 | *d* 143 |
| 8 | *Wcd* 185 | 18 | *b* 167 | 28 | *b* 124 |
| 9 | *bd* 181 | 19 | *a* 155 | 29 | *Ebc* 128 |
| 10 | 192 | 20 | *Ec* 149 | 30 | *d* 139 |
| | | | | 31 | 131 |

Mean, 30 days=143.9.

*a*=Passage of an average-sized group through the central meridian.
*b*=Passage of a large group or spot through the central meridian.
*c*=New formation of a group developing into a middle-sized or large center of activity; *E*: on the eastern part of the sun's disk, *W*: on the western part, *M*: in the central circle zone.
*d*=Entrance of a large or average-sized center of activity on the east limb.

# AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, *In Charge*]

By LOYD A. STEVENS

Mean free-air data, based on airplane weather observations made during the month of July 1937, are given in tables 1 to 3.

The mean free-air temperatures were generally below normal at all levels over the region east of the Rocky Mountains and near normal or slightly above elsewhere. The greatest negative departures occurred over Wright Field in the lower levels (−3.9° C. at 2 kilometers) and over Norfolk in the higher levels (−3.7° C. at 5 kilometers). The greatest positive departure (+2.0° C.) occurred over Spokane at 1 kilometer. The highest temperatures occurred over Oklahoma City at 0.5 and 1 kilometer, and over El Paso from 1.5 to 5 kilometers. At 5 kilometers, however, the temperature over El Paso was only 0.1° C. higher than over San Diego. There was, therefore, a gradual shifting of the statistical center of highest temperatures, toward the west, with altitude. There were two statistical centers of low temperatures located over Seattle and Sault Ste. Marie, respectively; the former having the lower temperatures at all levels except at 5 kilometers where they were equal in value. In general the mean free-air temperatures for July were higher at all levels than in June by 3° to 6° C. over the northern part of the country and by 1° C. over the extreme southern part. The greatest increase occurred at Oakland at 1 kilometer where the temperature for July (24.7° C.) was 8.2° C. higher than that for June (16.5° C.). At Kelly Field, however, the temperatures for July were slightly lower than for June at all levels above 1 kilometer. The same was true at Barksdale Field above 2 kilometers.

The mean free-air relative humidities at all levels were, in general, above normal over the northern part of the country east of the Rocky Mountains and below normal over the western Rocky Mountains and Pacific coast regions and in portions of the southeastern part of the country. The greatest negative departures (−10 percent) occurred over El Paso from 1.5 to 2.5 kilometers and the greatest positive departure (+12 percent) occurred over Norfolk at 3 kilometers.

The mean free-air barometric pressures and equivalent potential temperatures for the month are shown in table 3. In general there was an increase in the average pressure

of July over June at all stations and levels except over Kelly Field and Pensacola at 5 kilometers, where there was a decrease. The greatest increase occurred over the northern and western portions of the country, being greatest over Salt Lake City at 5 kilometers, where it amounted to 7 mb. Due to the greater increase in pressure over the northern part of the country, there was a resultant decrease in the south to north pressure gradient across the country in July as compared with June. The mean isobaric charts, as drawn from the values in table 3, were characterized by a statistical center of high pressure over Kelly Field at all levels and by relatively low pressure over the northern border with the low centers at Sault Ste. Marie and Seattle in the higher levels.

Free-air resultant winds, based on pilot balloon observations made near 5 a. m. (75th meridian time), are shown in table 4. For the most part, the resultant wind directions were remarkably close to the normal at nearly all stations and at all levels. The most outstanding exceptions occurred at Sault Ste. Marie at 0.5 kilometer where the direction for the current month was 187° (S.) and the normal 277° (W.). At Pensacola, also, the current resultant directions varied from the normal in a clockwise direction by amounts of 35° to 94° between 2 and 3 kilometers. At 4 kilometers the current resultant at Pensacola was 272° (W.) 2.0 m. p. s. while the normal is 44° (NE.) 0.7 m. p. s. At Oklahoma City the current resultant directions varied in a clockwise direction by amounts of 50° and 87°, respectively, at 2.5 and 3 kilometers and at 4 kilometers the current resultant was 349° (N.) 3.9 m. p. s. and the normal 103° (ESE) 0.7 m. p. s. Resultant velocities were, in general, below normal at all levels over the northeast and southwest portions of the country and above normal elsewhere. The greatest negative departure from the normal (−5.3 m. p. s.) occurred at Detroit at 5 kilometers and the greatest positive departure (+4.1 m. p. s.) occurred at Nashville at 3 kilometers.

Table 5 shows the maximum free-air wind velocities and their directions for various sections of the United States during July, as determined by pilot balloon observations. The extreme maximum for the month was 42.0 m. p. s. from the WSW. at 15,400 meters above sea level over Portland, Oreg.

The mean monthly equivalent potential temperatures and specific humidities are shown in tables 2 and 3, respectively. There was an increase in the mean equivalent potential temperature of July over June at nearly all stations and levels. The maximum increase (+17° A.) occurred at Salt Lake City at 1.5 kilometers. At Pensacola, however there was a decrease of 1° A. at 1.5, 2, and 2.5 kilometers, respectively, and of 2° A. at 3 kilometers. In general, there was an increase in the average specific humidities of July over June at most stations and levels, the maximum (+3.2 grams) occurring at Salt Lake City at 2 kilometers. At some stations and at certain levels, however, there were small decreases of 0.1 to 0.7 grams in the averages for July as compared with those for June. The decrease was most consistent at Pensacola where it occurred at all levels from 1.5 to 4 kilometers. The locations of the statistical centers of high and low specific humidities and equivalent potential temperatures agreed closely with those of high and low pressure except that the lowest mean specific humidities occurred at Oakland between 1 and 4 kilometers with no corresponding low pressure center over that region.

The outstanding features of the weather for the month included the unusual strength and the frequent far westward movement of the Atlantic HIGH and the frequent outbreaks of $N_{PP}$ and $P_P$ air from the Pacific HIGH. These latter air masses usually entered the country over the States of Washington and Oregon and caused unusually heavy rains over most of the Rocky Mountain regions where they were met by warm moist $T_A$ and $T_M$ air circulating around the western edge of the Atlantic HIGH. The latter air mass frequently dominated the entire southern portion of the country east of the Rocky Mountains, which probably accounted for the fact that the precipitation over this area was, in general, only 25 to 50 percent of normal. Relatively few well-defined LOWS developed within or entered the country during the month.

TABLE 1.—*Mean free-air temperatures (t), °C obtained by airplanes during July 1937. (Dep. represents departure from "normal" temperature.)*

| Station | Number of obs. | Altitude (meters) m. s. l. | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Surface | | 500 | | 1,000 | | 1,500 | | 2,000 | | 2,500 | | 3,000 | | 4,000 | | 5,000 | |
| | | t | Dep. | t | Dep. | t | Dep. | t | Dep. | t | Dep. | t | Dep. | t | Dep. | t | Dep. | t | Dep. |
| Barksdale Field [1] (Shreveport), La. (52 m) | 31 | 24.0 | −0.2 | 24.1 | −0.9 | 22.2 | −0.4 | 19.2 | −0.3 | 15.9 | −0.7 | 12.7 | −0.9 | 9.7 | −0.9 | 4.1 | −0.6 | | |
| Billings, Mont.[2] (1,089 m) | 31 | 19.6 | 0.0 | | | | | 21.9 | 0.0 | 19.6 | −0.2 | 16.1 | −0.3 | 12.4 | −0.5 | 4.7 | −0.5 | −2.8 | −0.2 |
| Boston, Mass.[1] (5 m) | 31 | 18.9 | | 20.2 | | 18.0 | | 15.3 | | 12.3 | | 9.8 | | 7.5 | | 2.1 | | −4.2 | |
| Cheyenne, Wyo.[2] (1,873 m) | 23 | 14.8 | −0.8 | | | | | | | 16.2 | −1.5 | 17.7 | −1.1 | 14.8 | −0.6 | 7.4 | +0.2 | −0.6 | +0.7 |
| Chicago, Ill. [3] (187 m) | 22 | 19.3 | | 21.3 | | 18.6 | | 15.1 | | 11.7 | | 8.7 | | 6.3 | | 1.0 | | −4.9 | |
| Coco Solo, Canal Zone [3] (15 m) | 25 | 25.6 | | 23.8 | | 21.1 | | 18.4 | | 15.9 | | 13.5 | | 10.7 | | 4.5 | | −1.5 | |
| El Paso, Tex.[3] (1,194 m) | 31 | 23.9 | −0.2 | | | | | 26.0 | +1.1 | 23.0 | +1.0 | 19.4 | +1.0 | 15.6 | +1.0 | 7.5 | +0.9 | 0.0 | +0.3 |
| Fargo, N. Dak.[3] (274 m) | 31 | 17.5 | −0.9 | 20.6 | −1.0 | 20.2 | −1.2 | 17.3 | −1.6 | 14.3 | −1.8 | 11.5 | −1.5 | 8.9 | −0.9 | 3.0 | 0.0 | −3.3 | +0.6 |
| Kelly Field (San Antonio), Tex.[1] (206 m) | 30 | 24.3 | +0.6 | 23.7 | −0.1 | 22.3 | +0.1 | 19.7 | −0.1 | 16.3 | −0.5 | 13.4 | −0.4 | 10.4 | −0.5 | 4.4 | −0.3 | −1.9 | −0.2 |
| Lakehurst, N. J.[3] (39 m) | 28 | 19.1 | −0.7 | 20.7 | −0.2 | 18.1 | −0.4 | 14.7 | −0.9 | 12.0 | −0.9 | 9.2 | −1.0 | 6.4 | −1.3 | 1.1 | −1.3 | −5.4 | −2.5 |
| Maxwell Field (Montgomery), Ala.[1] (52 m) | 31 | 23.4 | −0.7 | 24.5 | −0.2 | 21.8 | −0.4 | 18.4 | −0.5 | 15.0 | −0.8 | 12.1 | −0.8 | 9.1 | −0.9 | 3.4 | −0.5 | −1.9 | 0.0 |
| Mitchel Field (Hempstead, L. I.), N. Y.[1] (29 m) | 25 | 19.5 | −0.1 | 21.0 | +0.1 | 18.9 | −0.1 | 16.2 | 0.0 | 13.1 | 0.0 | 10.9 | +0.2 | 8.3 | +0.2 | 3.1 | +0.6 | | |
| Nashville, Tenn.[3] (180 m) | 30 | 20.9 | −1.2 | 23.0 | 0.0 | 20.2 | −0.8 | 16.3 | −1.5 | 13.3 | −1.7 | 10.6 | −1.5 | 7.8 | −1.2 | 1.9 | −1.1 | −3.4 | −0.4 |
| Norfolk, Va.[3] (10 m) | 26 | 23.5 | −1.2 | 22.8 | −1.2 | 19.7 | −2.0 | 16.4 | −2.3 | 13.0 | −2.6 | 10.0 | −2.8 | 6.9 | −3.1 | 1.0 | −2.9 | −4.3 | −3.7 |
| Oakland, Calif.[3] (2 m) | 31 | 14.6 | | 18.0 | | 24.7 | | 23.0 | | 20.0 | | 16.6 | | 13.0 | | 5.7 | | −1.7 | |
| Oklahoma City, Okla.[3] (391 m) | 31 | 24.1 | −0.1 | 25.4 | −0.3 | 25.3 | −0.4 | 22.4 | −0.2 | 19.3 | +0.2 | 15.7 | +0.1 | 11.7 | −0.2 | 4.2 | −0.6 | −2.9 | −1.3 |
| Omaha, Nebr.[3] (300 m) | 11 | 21.4 | | 23.5 | | 23.6 | | 20.7 | | 17.0 | | 13.4 | | 10.4 | | 4.1 | | −2.1 | |
| Pearl Harbor, T. H.[3] (6 m) | 30 | 23.5 | −0.1 | 21.2 | −0.2 | 17.9 | 0.0 | 15.2 | +0.2 | 12.9 | +0.1 | 10.8 | −0.2 | 8.6 | −0.2 | 5.1 | +0.9 | −0.5 | +0.5 |
| Pensacola, Fla.[3] (13 m) | 27 | 23.3 | −2.2 | 23.9 | −0.1 | 20.9 | −0.6 | 17.7 | −0.6 | 14.8 | −0.5 | 11.9 | −0.5 | 8.9 | −0.5 | 3.5 | +0.1 | −1.8 | +0.4 |
| St. Thomas, Virgin Islands [3] (8 m) | 31 | 28.8 | | 24.5 | | 20.7 | | 18.1 | | 16.0 | | 14.0 | | 10.9 | | 4.2 | | −1.5 | |
| Salt Lake City, Utah [3] (1,288 m) | 27 | 19.7 | | | | | | 22.9 | | 21.3 | | 18.0 | | 14.2 | | 6.4 | | −0.9 | |
| San Diego, Calif.[3] (10 m) | 31 | 19.4 | −1.2 | 17.3 | −1.1 | 21.8 | −0.5 | 22.8 | +0.5 | 20.6 | −0.4 | 17.5 | 0.0 | 13.8 | +0.1 | 6.7 | 0.0 | −0.1 | +0.3 |
| Sault Ste. Marie, Mich.[3] (221 m) | 31 | 14.6 | | 17.5 | | 16.3 | | 13.6 | | 11.0 | | 8.5 | | 5.8 | | 0.1 | | −6.3 | |
| Scott Field (Belleville), Ill.[1] (135 m) | 30 | 20.1 | −1.7 | 23.4 | −2.1 | 20.8 | −2.9 | 17.6 | −3.0 | 14.1 | −3.1 | 11.3 | −2.7 | 9.1 | −1.7 | 3.2 | −0.8 | −3.3 | −0.9 |
| Seattle, Wash.[3] (10 m) | 27 | 13.2 | | 13.3 | | 12.6 | | 11.1 | | 9.4 | | 7.4 | | 5.2 | | 0.2 | | −6.3 | |
| Selfridge Field (Mount Clemens), Mich.[1] (177 m) | 10 | 17.1 | | 20.2 | | 17.8 | | 14.6 | | 11.1 | | 8.5 | | 5.9 | | 0.7 | | −5.4 | |
| Spokane, Wash.[3] (596 m) | 31 | 16.7 | +1.1 | | | 22.4 | +2.0 | 20.5 | +1.6 | 16.9 | +1.5 | 13.0 | +1.4 | 9.6 | +1.4 | 2.9 | +1.5 | −4.5 | +1.2 |
| Washington, D. C.[3] (13 m) | 27 | 21.8 | −1.7 | 21.9 | −0.8 | 19.2 | −1.5 | 16.0 | −2.0 | 12.9 | −2.2 | 9.7 | −2.4 | 6.6 | −2.7 | 1.2 | −2.7 | −4.0 | −2.4 |
| Wright Field (Dayton), Ohio [1] (244 m) | 28 | 17.9 | −2.1 | 21.3 | −1.1 | 18.3 | −3.2 | 14.6 | −3.7 | 11.2 | −3.9 | 8.7 | −3.5 | 6.2 | −3.1 | 0.5 | −2.8 | −5.4 | −2.8 |

[1] Army. [2] Weather Bureau. [3] Navy.

Observations taken about 4 a. m. 75th Meridian time, except by Navy stations along the Pacific coast and Hawaii, where they are taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Barksdale, 93 (3); Billings, 124 (4); Cheyenne, 115 (4); El Paso, 92 (3); Fargo, 124 (4); Kelly Field, 120 (4); Lakehurst, 85 (3); Maxwell Field, 116 (4); Mitchel Field, 83 (3); Nashville, 122 (4); Norfolk, 185 (8); Oklahoma City, 123 (4); Pearl Harbor, 122 (4); Pensacola, 237 (10); San Diego, 227 (9); Scott Field, 119 (4); Spokane, 123 (4); Washington, 231 (10); Wright Field, 120 (4).

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during July 1937. (Dep. represents departure from "normal" relative humidity)*

| Stations | Number of observations | Altitude (meters) m. s. l. | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Surface | | | 500 | | | 1,000 | | | 1,500 | | | 2,000 | | | 2,500 | | | 3,000 | | | 4,000 | | | 5,000 | | |
| | | q | R. H. | | q | R. H. | | q | R. H. | | q | R. H. | | q | R. H. | | q | R. H. | | q | R. H. | | q | R. H. | | q | R. H. | |
| | | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. | | Mean | Dep. |
| Barksdale Field, La | 31 | 16.0 | 86 | −1 | 13.6 | 69 | +1 | 11.3 | 61 | −4 | 10.3 | 63 | −2 | 9.0 | 64 | +1 | 7.8 | 65 | +5 | 6.4 | 61 | +3 | 4.6 | 58 | +1 | | | |
| Billings, Mont | 31 | 9.0 | 56 | +3 | | | | | | | 8.7 | 45 | +3 | 7.8 | 44 | +3 | 7.3 | 48 | +4 | 6.8 | 54 | +8 | 5.1 | 61 | +11 | 3.4 | 60 | +5 |
| Boston, Mass | 31 | 11.5 | 84 | | 10.2 | 66 | | 8.9 | 62 | | 8.1 | 63 | | 7.2 | 64 | | 6.2 | 62 | | 5.2 | 57 | | 3.4 | 48 | | 2.5 | 49 | |
| Cheyenne, Wyo | 23 | 9.3 | 71 | +8 | | | | | | | | | | 8.9 | 62 | +6 | 7.3 | 43 | 0 | 6.5 | 44 | +1 | 5.1 | 51 | +3 | 4.1 | 61 | +4 |
| Chicago, Ill | 22 | 11.4 | 81 | | 10.8 | 65 | | 9.4 | 63 | | 8.4 | 67 | | 7.6 | 71 | | 6.2 | 68 | | 5.1 | 61 | | 3.8 | 58 | | 2.6 | 51 | |
| Coco Solo, Canal Zone | 25 | 19.6 | 95 | | 17.2 | 88 | | 14.9 | 85 | | 13.2 | 84 | | 11.4 | 80 | | 9.3 | 72 | | 7.2 | 64 | | 5.5 | 67 | | 4.0 | 64 | |
| El Paso, Tex | 31 | 9.5 | 45 | −3 | | | | | | | 8.9 | 36 | −10 | 8.1 | 37 | −10 | 7.3 | 39 | −10 | 6.5 | 42 | −9 | 5.7 | 55 | −8 | 4.3 | 62 | −4 |
| Fargo, N. Dak | 31 | 10.5 | 82 | +4 | 10.2 | 64 | +2 | 8.8 | 54 | +2 | 8.3 | 57 | +7 | 7.3 | 57 | +10 | 6.2 | 55 | +9 | 5.2 | 52 | +6 | 3.6 | 48 | +2 | 2.4 | 44 | −2 |
| Kelly Field, Tex | 30 | 16.0 | 83 | −7 | 15.5 | 81 | −4 | 12.1 | 65 | −6 | 10.4 | 62 | −4 | 9.0 | 63 | 0 | 7.2 | 57 | −1 | 6.0 | 55 | +1 | 4.2 | 51 | +1 | 3.0 | 50 | 0 |
| Lakehurst, N. J | 28 | 12.6 | 92 | +2 | 10.4 | 65 | −2 | 9.1 | 63 | −1 | 8.4 | 68 | 0 | 6.8 | 62 | −3 | 5.7 | 59 | −2 | 4.9 | 57 | +1 | 3.4 | 51 | −1 | 3.0 | 63 | +13 |
| Maxwell Field, Ala | 31 | 15.5 | 86 | −2 | 12.6 | 64 | −7 | 11.6 | 64 | −5 | 10.5 | 67 | −5 | 9.0 | 67 | −2 | 7.2 | 61 | −2 | 6.0 | 59 | −3 | 4.3 | 56 | −4 | 2.9 | 48 | −6 |
| Mitchel Field, N. Y | 25 | 12.6 | 90 | −1 | 12.4 | 76 | 0 | 11.1 | 73 | +2 | 9.8 | 73 | +1 | 8.9 | 70 | +2 | 7.5 | 69 | 0 | 6.4 | 67 | +2 | 4.3 | 57 | −1 | | | |
| Nashville, Tenn | 30 | 13.2 | 84 | −4 | 12.7 | 69 | −1 | 11.7 | 71 | +2 | 10.0 | 74 | +4 | 8.0 | 68 | +3 | 6.0 | 57 | −1 | 5.0 | 55 | −2 | 3.4 | 48 | −3 | 2.1 | 38 | −8 |
| Norfolk, Va | 26 | 15.0 | 84 | +4 | 12.5 | 70 | 0 | 10.8 | 68 | +3 | 9.6 | 70 | +6 | 8.4 | 72 | +9 | 7.1 | 70 | +10 | 6.0 | 69 | +12 | 4.1 | 63 | +8 | 2.1 | 42 | −3 |
| Oakland, Calif | 31 | 8.9 | 87 | | 9.3 | 69 | | 6.7 | 31 | | 5.1 | 25 | | 4.1 | 22 | | 3.5 | 22 | | 3.0 | 23 | | 2.2 | 25 | | 1.8 | 29 | |
| Oklahoma City, Okla | 31 | 14.0 | 72 | +1 | 14.7 | 69 | +3 | 12.8 | 57 | +2 | 11.6 | 58 | +4 | 10.0 | 57 | +3 | 8.5 | 58 | +4 | 7.7 | 63 | +6 | 5.5 | 68 | +10 | 3.4 | 61 | +7 |
| Omaha, Nebr | 11 | 12.8 | 78 | | 11.7 | 62 | | 9.9 | 48 | | 9.2 | 50 | | 8.6 | 56 | | 7.5 | 59 | | 6.0 | 54 | | 3.6 | 44 | | 2.0 | 35 | |
| Pearl Harbor, T. H | 30 | 14.0 | 78 | −2 | 13.2 | 80 | 0 | 12.3 | 87 | +3 | 10.4 | 82 | +2 | 8.5 | 73 | +4 | 6.1 | 57 | +5 | 5.0 | 52 | +10 | 2.5 | 29 | +2 | 1.5 | 24 | 0 |
| Pensacola, Fla | 27 | 16.3 | 92 | +5 | 14.6 | 75 | −4 | 12.2 | 71 | −4 | 10.3 | 69 | −4 | 8.4 | 64 | −5 | 7.0 | 61 | −5 | 5.8 | 58 | −5 | 4.4 | 56 | −4 | 3.0 | 51 | −4 |
| St. Thomas, Virgin Islands | 31 | 17.6 | 72 | | 17.3 | 86 | | 15.5 | 92 | | 12.6 | 83 | | 9.6 | 68 | | 6.8 | 51 | | 5.5 | 49 | | 3.9 | 47 | | 2.7 | 42 | |
| Salt Lake City, Utah | 27 | 10.4 | 63 | | | | | | | | 10.9 | 53 | | 9.3 | 47 | | 8.0 | 47 | | 6.9 | 49 | | 5.6 | 59 | | 4.4 | 67 | |
| San Diego, Calif | 31 | 11.4 | 81 | +2 | 10.7 | 83 | +2 | 8.3 | 46 | −4 | 6.8 | 33 | −6 | 5.7 | 30 | −3 | 5.0 | 30 | −5 | 4.9 | 34 | −5 | 3.8 | 39 | −5 | 2.9 | 41 | −5 |
| Sault Ste. Marie, Mich | 31 | 9.5 | 90 | | 9.4 | 72 | | 9.2 | 71 | | 8.2 | 71 | | 7.2 | 69 | | 5.8 | 63 | | 4.8 | 59 | | 3.4 | 56 | | 2.3 | 52 | |
| Scott Field, Ill | 30 | 13.3 | 89 | +5 | 11.7 | 62 | +1 | 10.7 | 63 | +4 | 9.8 | 66 | +6 | 8.5 | 68 | +8 | 6.8 | 61 | +4 | 5.6 | 55 | +1 | 4.0 | 52 | −1 | 2.7 | 50 | −1 |
| Seattle, Wash | 27 | 8.1 | 87 | | 7.9 | 79 | | 6.9 | 68 | | 6.0 | 63 | | 5.5 | 60 | | 4.5 | 52 | | 3.6 | 46 | | 2.3 | 37 | | 1.5 | 34 | |
| Selfridge Field, Mich | 10 | 11.1 | 88 | | 9.6 | 62 | | 9.1 | 62 | | 8.2 | 64 | | 7.3 | 69 | | 5.8 | 63 | | 4.3 | 54 | | 2.6 | 39 | | 1.4 | 27 | |
| Spokane, Wash | 31 | 9.2 | 72 | +8 | | | | 7.7 | 41 | −6 | 6.6 | 37 | −6 | 6.1 | 41 | −5 | 5.7 | 46 | −3 | 5.1 | 49 | −1 | 3.5 | 46 | −4 | 2.0 | 40 | −8 |
| Washington, D. C | 27 | 13.7 | 85 | +8 | 10.9 | 64 | −1 | 10.0 | 65 | +4 | 8.6 | 65 | +3 | 7.4 | 64 | +2 | 6.5 | 66 | +6 | 5.3 | 63 | +5 | 3.5 | 53 | +4 | 2.4 | 47 | +3 |
| Wright Field, Ohio | 28 | 12.0 | 92 | +7 | 11.1 | 67 | −1 | 10.0 | 69 | +6 | 8.9 | 72 | +7 | 7.3 | 71 | +8 | 5.4 | 58 | +1 | 4.7 | 56 | +1 | 3.2 | 50 | +1 | 2.2 | 46 | +1 |

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures ($\Theta_e$), in °A. obtained by airplanes during July 1937*

| Station | Number of observations | Altitude (meters) m. s. l. | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Surface | | 500 | | 1,000 | | 1,500 | | 2,000 | | 2,500 | | 3,000 | | 4,000 | | 5,000 | |
| | | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ | P | $\Theta_e$ |
| Barksdale Field, La | 31 | 1,010 | 341 | 960 | 340 | 906 | 337 | 855 | 336 | 807 | 334 | 760 | 333 | 716 | 331 | 634 | 331 | | |
| Billings, Mont | 31 | 892 | 329 | | | | | 852 | 335 | 804 | 336 | 758 | 336 | 714 | 335 | 633 | 333 | 560 | 331 |
| Boston, Mass | 31 | 1,014 | 323 | 957 | 326 | 903 | 326 | 852 | 326 | 803 | 325 | 755 | 325 | 711 | 325 | 629 | 325 | 556 | 326 |
| Cheyenne, Wyo | 23 | 815 | 333 | | | | | | | 804 | 335 | 757 | 338 | 715 | 338 | 633 | 336 | 560 | 336 |
| Chicago, Ill | 22 | 993 | 325 | 957 | 329 | 904 | 327 | 852 | 327 | 804 | 326 | 756 | 324 | 710 | 324 | 629 | 326 | 555 | 326 |
| Coco Solo, Canal Zone | 25 | 1,008 | 353 | 951 | 350 | 899 | 347 | 848 | 344 | 800 | 342 | 753 | 339 | 710 | 335 | 628 | 335 | 556 | 324 |
| El Paso, Tex | 31 | 882 | 336 | | | | | 851 | 340 | 804 | 340 | 758 | 340 | 115 | 339 | 635 | 338 | 562 | 337 |
| Fargo, N. Dak | 31 | 980 | 321 | 955 | 327 | 902 | 328 | 850 | 329 | 802 | 328 | 756 | 328 | 711 | 327 | 629 | 327 | 555 | 328 |
| Kelly Field, Tex | 30 | 994 | 343 | 962 | 344 | 909 | 339 | 858 | 336 | 810 | 334 | 763 | 332 | 719 | 330 | 638 | 330 | 564 | 330 |
| Lakehurst, N. J | 28 | 1,010 | 326 | 958 | 328 | 904 | 326 | 853 | 326 | 804 | 324 | 756 | 323 | 712 | 323 | 630 | 324 | 556 | 326 |
| Maxwell Field, Ala | 31 | 1,010 | 339 | 960 | 337 | 907 | 337 | 856 | 336 | 808 | 333 | 760 | 330 | 716 | 329 | 634 | 329 | 561 | 330 |
| Mitchel Field, N. Y | 25 | 1,013 | 326 | 960 | 332 | 906 | 332 | 854 | 331 | 805 | 331 | 758 | 330 | 713 | 330 | 632 | 329 | | |
| Nashville, Tenn | 30 | 995 | 331 | 960 | 336 | 906 | 336 | 855 | 332 | 806 | 329 | 759 | 325 | 715 | 325 | 633 | 325 | 560 | 326 |
| Norfolk, Va | 26 | 1,015 | 338 | 958 | 335 | 905 | 332 | 853 | 331 | 804 | 330 | 757 | 328 | 713 | 327 | 630 | 326 | 556 | 325 |
| Oakland, Calif | 31 | 1,014 | 311 | 956 | 321 | 903 | 327 | 853 | 326 | 805 | 325 | 759 | 325 | 716 | 324 | 634 | 325 | 561 | 327 |
| Oklahoma City, Okla | 31 | 969 | 340 | 957 | 345 | 904 | 345 | 854 | 344 | 806 | 342 | 760 | 339 | 716 | 337 | 635 | 334 | 562 | 330 |
| Omaha, Nebr | 11 | 980 | 332 | 957 | 334 | 904 | 334 | 854 | 335 | 805 | 335 | 759 | 333 | 715 | 331 | 633 | 328 | 560 | 327 |
| Pearl Harbor, T. H | 30 | 1,016 | 335 | 959 | 335 | 906 | 335 | 854 | 332 | 806 | 330 | 759 | 326 | 715 | 326 | 634 | 325 | 560 | 327 |
| Pensacola, Fla | 27 | 1,017 | 340 | 961 | 342 | 907 | 338 | 854 | 334 | 805 | 332 | 758 | 330 | 714 | 329 | 632 | 330 | 558 | 331 |
| St. Thomas, Virgin Island | 31 | 1,018 | 350 | 964 | 350 | 910 | 347 | 858 | 341 | 810 | 336 | 762 | 331 | 719 | 330 | 637 | 328 | 563 | 326 |
| Salt Lake City, Utah | 27 | 872 | 335 | | | | | 851 | 343 | 803 | 342 | 757 | 340 | 714 | 338 | 633 | 337 | 561 | 336 |
| San Diego, Calif | 31 | 1,012 | 323 | 957 | 324 | 903 | 329 | 852 | 331 | 804 | 331 | 758 | 331 | 715 | 331 | 634 | 331 | 562 | 332 |
| Sault Ste. Marie, Mich | 31 | 988 | 315 | 956 | 321 | 902 | 324 | 850 | 324 | 801 | 324 | 754 | 323 | 710 | 323 | 627 | 324 | 553 | 324 |
| Scott Field, Ill | 30 | 1,000 | 330 | 960 | 334 | 906 | 333 | 855 | 333 | 806 | 331 | 759 | 328 | 715 | 326 | 633 | 326 | 560 | 326 |
| Seattle, Wash | 27 | 1,018 | 307 | 961 | 312 | 905 | 314 | 852 | 315 | 802 | 318 | 754 | 318 | 710 | 318 | 628 | 320 | 554 | 321 |
| Selfridge Field, Mich | 10 | 994 | 322 | 958 | 324 | 905 | 326 | 853 | 325 | 804 | 324 | 756 | 322 | 712 | 321 | 629 | 321 | 556 | 321 |
| Spokane, Wash | 31 | 945 | 321 | | | 902 | 327 | 850 | 328 | 804 | 327 | 757 | 327 | 714 | 327 | 632 | 326 | 558 | 325 |
| Washington, D. C | 27 | 1,016 | 332 | 959 | 330 | 905 | 330 | 853 | 328 | 804 | 326 | 757 | 326 | 713 | 324 | 630 | 325 | 556 | 327 |
| Wright Field, Ohio | 28 | 987 | 325 | 958 | 330 | 904 | 328 | 853 | 327 | 804 | 324 | 756 | 322 | 712 | 322 | 629 | 323 | 555 | 324 |

TABLE 4.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during July, 1937*

[Wind from N=360°, E=90°, etc.]

| Altitude (m.) m. s. l. | Albuquerque, N. Mex. (1,554 m.) | | Atlanta, Ga. (309 m.) | | Billings, Mont. (1,088 m.) | | Boston, Mass. (15 m.) | | Cheyenne, Wyo. (1,873 m.) | | Chicago, Ill. (192 m.) | | Cincinnati, Ohio (153 m.) | | Detroit, Mich. (204 m.) | | Fargo, N. Dak. (274 m.) | | Houston, Tex. (21 m.) | | Key West, Fla. (11 m.) | | Medford, Oreg. (410 m.) | | Nashville, Tenn. (194 m.) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity |
| | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | |
| Surface | 2 | 1.8 | 289 | 1.0 | 307 | 2.3 | 260 | 1.5 | 281 | 2.6 | 238 | 1.8 | 140 | 0.2 | 270 | 1.7 | 92 | 0.3 | 167 | 1.0 | 119 | 2.9 | 196 | 0.5 | 237 | 0.9 |
| 500 | ----- | ----- | 291 | 3.7 | ----- | ----- | 292 | 4.4 | ----- | ----- | 250 | 5.2 | 259 | 3.1 | 277 | 4.1 | 142 | 2.5 | 196 | 7.9 | 122 | 5.8 | 237 | 0.9 | 243 | 2.1 |
| 1,000 | ----- | ----- | 286 | 4.6 | ----- | ----- | 290 | 3.9 | ----- | ----- | 268 | 5.2 | 271 | 4.2 | 289 | 5.5 | 224 | 2.4 | 195 | 7.3 | 132 | 5.0 | 288 | 1.6 | 249 | 3.3 |
| 1,500 | ----- | ----- | 270 | 4.4 | 312 | 0.9 | 287 | 4.7 | ----- | ----- | 281 | 4.7 | 271 | 4.5 | 286 | 5.8 | 258 | 2.9 | 184 | 5.7 | 129 | 3.8 | 358 | 0.4 | 250 | 4.6 |
| 2,000 | 112 | 0.9 | 270 | 4.3 | 252 | 1.9 | 288 | 5.3 | 260 | 2.9 | 270 | 5.1 | 267 | 4.0 | 287 | 5.9 | 278 | 4.8 | 174 | 4.9 | 132 | 2.7 | 35 | 1.6 | 248 | 4.5 |
| 2,500 | 216 | 1.5 | 255 | 4.6 | 244 | 3.2 | 286 | 6.5 | 235 | 3.4 | 266 | 4.4 | 265 | 4.0 | 280 | 6.8 | 278 | 6.1 | 159 | 3.8 | 151 | 2.3 | 195 | 1.4 | 247 | 4.0 |
| 3,000 | 257 | 2.2 | 261 | 5.0 | 260 | 4.6 | 282 | 6.9 | 248 | 4.4 | 280 | 1.9 | 282 | 3.1 | 274 | 6.4 | 301 | 4.2 | 150 | 3.2 | 152 | 3.2 | 207 | 4.4 | 251 | 5.7 |
| 4,000 | 240 | 2.3 | 252 | 5.2 | 268 | 8.5 | 298 | 5.9 | 284 | 5.2 | 262 | 2.4 | ----- | ----- | 298 | 4.0 | 300 | 6.9 | 107 | 1.5 | ----- | ----- | 219 | 7.2 | ----- | ----- |
| 5,000 | 280 | 0.3 | ----- | ----- | ----- | ----- | ----- | ----- | 291 | 5.4 | ----- | ----- | ----- | ----- | 293 | 3.7 | ----- | ----- | 97 | 0.6 | ----- | ----- | 231 | 10.7 | ----- | ----- |

| Altitude (m.) m. s. l. | Newark, N. J. (14 m.) | | Oakland, Calif. (8 m.) | | Oklahoma City, Okla. (402 m.) | | Omaha, Nebr. (306 m.) | | Pearl Harbor, Territory of Hawaii [1] (68 m.) | | Pensacola, Fla.[1] (24 m.) | | St. Louis, Mo. (170 m.) | | Salt Lake City, Utah (1,294 m.) | | San Diego, Calif. (15 m.) | | Sault Ste. Marie, Mich. (198 m.) | | Seattle, Wash. (14 m.) | | Spokane, Wash. (603 m.) | | Washington, D. C. (10 m.) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity |
| | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | |
| Surface | 281 | 0.3 | 346 | 1.6 | 169 | 4.7 | 154 | 1.6 | 59 | 4.8 | 312 | 1.3 | 201 | 1.2 | 156 | 3.0 | 2 | 1.1 | 106 | 0.2 | 117 | 0.4 | 117 | 1.6 | 308 | 1.2 |
| 500 | 312 | 2.7 | 270 | 2.3 | 179 | 7.5 | 180 | 5.4 | 70 | 7.9 | 287 | 4.2 | 222 | 4.9 | ----- | ----- | 275 | 0.4 | 187 | 1.3 | 32 | 1.9 | ----- | ----- | 312 | 4.2 |
| 1,000 | 305 | 2.8 | 313 | 3.1 | 210 | 11.9 | 215 | 6.7 | 78 | 8.5 | 276 | 4.2 | 251 | 4.8 | ----- | ----- | 339 | 2.5 | 257 | 2.8 | 23 | 0.9 | 212 | 2.6 | 318 | 5.8 |
| 1,500 | 283 | 2.9 | 332 | 1.2 | 230 | 8.0 | 236 | 5.1 | 86 | 6.6 | 252 | 3.9 | 266 | 4.3 | 157 | 4.0 | 292 | 3.6 | 284 | 3.9 | 315 | 1.3 | 247 | 3.4 | 309 | 5.3 |
| 2,000 | 277 | 4.1 | 209 | 1.6 | 245 | 5.2 | 267 | 3.1 | 92 | 5.9 | 251 | 2.4 | 283 | 4.0 | 162 | 3.2 | 272 | 2.5 | 299 | 4.1 | 296 | 2.4 | 246 | 5.1 | 284 | 4.9 |
| 2,500 | 277 | 4.7 | 194 | 2.6 | 269 | 3.0 | 299 | 3.0 | 85 | 5.0 | 263 | 2.5 | 302 | 4.1 | 190 | 1.9 | 198 | 1.2 | 305 | 4.4 | 278 | 3.6 | 246 | 5.7 | 279 | 4.9 |
| 3,000 | 270 | 5.4 | 189 | 5.4 | 299 | 2.5 | 298 | 4.0 | 104 | 3.5 | 266 | 1.6 | 321 | 4.1 | 249 | 2.3 | 137 | 2.5 | 304 | 4.2 | 273 | 4.9 | 238 | 7.0 | 269 | 5.2 |
| 4,000 | 267 | 6.7 | ----- | ----- | 349 | 3.9 | 321 | 4.6 | ----- | ----- | 272 | 2.0 | 330 | 3.2 | 255 | 3.8 | ----- | ----- | 314 | 5.4 | 264 | 8.7 | 248 | 10.0 | 281 | 4.0 |
| 5,000 | 257 | 6.0 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 285 | 5.2 | ----- | ----- | ----- | ----- | 264 | 9.5 | ----- | ----- | ----- | ----- |

[1] Navy stations.

TABLE 5.—*Maximum free-air wind velocities (M. P. S.), for different sections of the United States based on pilot-balloon observations during July 1937*

| Section | Surface to 2,500 meters (m. s. l.) | | | | | Between 2,500 and 5,000 meters (m. s. l.) | | | | | Above 5,000 meters (m. s. l.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum velocity | Direction | Altitude (m) M. S. L. | Date | Station | Maximum velocity | Direction | Altitude (m) M. S. L. | Date | Station | Maximum velocity | Direction | Altitude (m) M. S. L. | Date | Station |
| Northeast [1] | 35.5 | SW | 1,210 | 26 | Buffalo | 30.4 | WSW | 4,310 | 26 | Columbus | 36.8 | SW | 9,900 | 22 | Albany. |
| East-Central [2] | 22.6 | WSW | 860 | 26 | Richmond | 25.6 | WNW | 3,569 | 18 | Richmond | 38.8 | ENE | 7,920 | 1 | Greensboro. |
| Southeast [3] | 22.5 | ENE | 1,400 | 2 | Tampa | 23.5 | W | 4,660 | 1 | Spartanburg | 25.6 | WSW | 5,020 | 1 | Spartanburg. |
| North-Central [4] | 37.9 | SW | 1,508 | 9 | Bismarck | 30.0 | WNW | 2,990 | 16 | Detroit | 31.3 | W | 10,190 | 19 | Detroit. |
| Central [5] | 26.4 | W | 2,465 | 15 | Davenport | 30.0 | NW | 4,985 | 4 | Davenport | 40.4 | W | 11,140 | 27 | Indianapolis. |
| South-Central [6] | 27.4 | SSE | 2,110 | 9 | Amarillo | 23.5 | NNW | 3,590 | 1 | Memphis | 32.0 | NNW | 7,910 | 30 | Memphis. |
| Northwest [7] | 25.4 | WSW | 886 | 13 | Pendleton | 36.4 | SSW | 4,460 | 1 | Medford | 42.0 | WSW | 15,414 | 9 | Portland. |
| West-Central [8] | 26.0 | SSW | 2,500 | 31 | Modena | 35.6 | WSW | 2,860 | 14 | Winnemucca | 41.6 | SSW | 12,015 | 29 | Modena. |
| Southwest [9] | 19.3 | WSW | 2,400 | 16 | Havre | 28.6 | WSW | 5,000 | 21 | Havre | 37.2 | WSW | 11,820 | 13 | Las Vegas. |

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and Northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and Western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, Northern Nevada, and Northern California.
[9] Southern California, Southern Nevada, Arizona, New Mexico, and extreme West Texas.

# RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD *in charge*]

By BENNETT SWENSON

Heavy rains caused sudden freshets in the Belle Fourche and White River watersheds in South Dakota on July 13–14 and resulted in losses of about $61,300 and $60,000, respectively. Two lives were lost in connection with the flood in the White River. Otherwise, no damage of consequence was reported from the floods, which were mainly of a minor character, during the month.

Light, but very sudden, floods occurred in the middle reaches of the Grand River in Missouri on July 14–15 and again on the 20th. Heavy rains on July 12–14 averaged 3.31 inches over the Grand River watershed and caused the stage at Chillicothe, Mo., to rise from 1.9 feet on July 11 to a crest of 20.1 feet on the 14th. Moderately heavy rains on the 18th–19th caused a second rise in the river.

The heavy rains over South Dakota on July 12–13 and on July 18–19 between Sioux City, Iowa, and Kansas City, Mo., caused sharp rises in the middle Missouri River. Flood stage was exceeded, however, only at Nebraska City, Nebr., with a crest 0.5 foot above flood stage on July 20.

An interesting feature during the month was the phenomenally heavy precipitation that occurred over the St. Francis River Basin in Missouri and Arkansas. During the 24-hour period ending on the morning of July 4, 10.33 inches of rain fell at Fisk, Mo., and 7.45 inches at St. Francis, Ark. Due to the condition of the ground and the low stages in the streams at this time of the year, the excessive rain resulted in only light flooding in the St. Francis River at Manila and St. Francis, Ark.

*Table of flood stages during July 1937*

[All dates in July unless otherwise specified]

| River and station | Flood stage | Above flood stages—dates | | Crest | |
|---|---|---|---|---|---|
| | | From— | To— | Stage | Date |
| ST. LAWRENCE DRAINAGE | | | | | |
| *Lake Erie* | | | | | |
| St. Joseph: Montpelier, Ohio | *Feet* 10 | 26 | 27 | *Feet* 10.4 | 27 |
| ATLANTIC SLOPE DRAINAGE | | | | | |
| James: Columbia, Va | 10 | 20 | 22 | 14.9 | 21 |
| Tar: Rocky Mount, N. C | 8 | 27 | 28 | 9.0 | 28 |
| Little: Kenly, N. C | 8 | 28 | 29 | 9.5 | 29 |
| Santee: Rimini, S. C | 12 | 1 | 4 | 12.7 | 3 |
| | | 28 | (1) | 12.5 | 30 |
| MISSISSIPPI SYSTEM | | | | | |
| *Missouri Basin* | | | | | |
| Grand: Chillicothe, Mo | 18 | 14 | 15 | 20.1 | 14 |
| | | 20 | 20 | 19.0 | 20 |
| Missouri: Nebraska City, Nebr | 15 | 19 | 20 | 15.5 | 20 |
| *Ohio Basin* | | | | | |
| West Fork of White: Anderson, Ind | 8 | 13 | 18 | 9.1 | 14, 16 |
| | | 27 | 27 | 8.1 | 27 |
| *Lower Mississippi Basin* | | | | | |
| Big Lake Outlet: Manila, Ark | 10 | 7 | 14 | 11.1 | 10–11 |
| St. Francis: St. Francis, Ark | 18 | 6 | 11 | 18.4 | 7, 10 |

[1] Above flood stage at end of month.

# WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, WILLIS E. HURD, *acting in charge*]

## NORTH ATLANTIC OCEAN, JULY 1937

By H. C. HUNTER

*Atmospheric pressure.*—Over waters adjacent to Europe the pressure again averaged slightly greater than normal. Most of the ocean otherwise had pressure somewhat less than normal, the greatest known deficiency being 0.10 inch, at Reykjavik, Iceland. The Gulf of Mexico is indicated as having a very little above normal pressure.

The extremes of pressure found in the vessel reports at hand are 30.51 and 29.24 inches. The higher reading was noted during the forenoon of the 11th, approximately midway between Horta and Lisbon, on the French steamship *Capitaine Paul Lemerle*. Two liners only a few miles apart, near 47° N., 36° W., the Belgian *Emile Franoqui* and the Dutch *Edam*, each recorded the lower reading on the forenoon of the 16th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, July 1937*

| Stations | Average pressure | Departure | Highest | Date | Lowest | Date |
|---|---|---|---|---|---|---|
| | *Inches* | *Inch* | *Inches* | | *Inches* | |
| Julianehaab, Greenland | 29.75 | −0.05 | 30.02 | 8 | 29.32 | 31 |
| Reykjavik, Iceland | 29.74 | −.10 | 30.12 | 6 | 29.35 | 30 |
| Lerwick, Shetland Islands | 29.88 | +.08 | 30.21 | 17 | 29.50 | 22 |
| Valencia, Ireland | 30.01 | +.03 | 30.27 | 19 | 29.65 | 23 |
| Lisbon, Portugal | 30.05 | +.03 | 30.18 | 9 | 29.86 | 30 |
| Madeira | 30.06 | +.01 | 30.18 | 9, 14, 15 | 29.92 | 20 |
| Horta, Azores | 30.20 | −.07 | 30.46 | 10 | 29.76 | 25 |
| Belle Isle, Newfoundland | 29.87 | −.02 | 30.16 | 24, 29 | 29.46 | 3 |
| Halifax, Nova Scotia | 29.97 | +.02 | 30.22 | 30 | 29.54 | 16 |
| Nantucket | 29.97 | −.01 | 30.18 | 29 | 29.60 | 16 |
| Hatteras | 30.00 | −.01 | 30.17 | 28 | 29.53 | 31 |
| Bermuda | 30.17 | −.01 | 30.26 | 27, 28 | 30.04 | 13 |
| Turks Island | 30.05 | −.02 | 30.18 | 1 | 29.95 | 7 |
| Key West | 30.04 | +.01 | 30.14 | 10 | 29.93 | 1 |
| New Orleans | 30.04 | +.04 | 30.18 | 10 | 29.86 | 1 |

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

*Cyclones and gales.*—There was somewhat more storm activity than there had been during the quiet June just previous. Apart from the vicinity of the American coast the most notable storm occurred about the middle of the month. This was close to the Middle Atlantic States on the 12th, as a LOW of only moderate strength; but as it moved toward the east-northeast the energy increased, and near midocean some vessels met strong gales (force 9) between noon and midnight of the 16th. There was decidedly high pressure at this time over and near the Bay of Biscay, and the LOW turned more toward the north-northeast, away from the chief steamship routes, and was centered near Iceland late on the 18th with somewhat diminished force.

From the northeastern part of the Gulf of Mexico northward near the United States coast a disturbance usually of small size but considerable strength passed just before the close of the month. Midnight of July 31 found this storm in about the latitude of New Jersey. The greatest wind force reported by any vessel meeting it was 11, and it was only in connection with this LOW that any July vessel report from North Atlantic waters has mentioned that force. A detailed account of this disturbance appears elsewhere in this issue.

*Fog.*—As is expected in July, there was considerable fog over North Atlantic waters to northward of the fortieth parallel. The western areas had, as a rule, somewhat less fog than during the month of June just preceding; but the eastern areas to northward of 45° latitude noted a little more fog than June had brought. Reports indicate the eastern 5° square of greatest occurrence to have been that from 45° to 50° N., 30° to 35° W., with 10 days, chiefly after the 17th. Close to the British Isles fog was experienced mainly on the opening days and about the 12th and 18th.

In the Grand Banks region fog was prevalent most of the month, but somewhat less than usual from the 9th to 16th. The square 40° to 45° N., 45° to 50° W., led all others anywhere in the North Atlantic, with 20 days. Near Cape Cod and Western Nova Scotia the square 40° to 45° N., 65° to 70° W., had 18 days.

Waters near Long Island had much less fog than during June, and the decrease near the New Jersey coast and Delaware Bay was even more marked. A very little fog was met, however, still farther southward, even near the coast of North Carolina.

Two accidents due to fog were noted as occurring near the Massachusetts coast. In the more serious of these, on the 12th, Handkerchief Shoals lightship was struck and damaged enough to compel withdrawal for repairs, one of the crew suffering injury.

## OCEAN GALES AND STORMS, JULY 1937

| Vessel | Voyage | | Position at time of lowest barometer | | Gale began July— | Time of lowest barometer July— | Gale ended July— | Lowest barometer | Direction of wind when gale began | Direction and force of wind at time of lowest barometer | Direction of wind when gale ended | Direction and highest force of wind | Shifts of wind near time of lowest barometer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From— | To— | Latitude | Longitude | | | | | | | | | |
| **NORTH ATLANTIC OCEAN** | | | ° ′ | ° ′ | | | | *Inches* | | | | | |
| Turrialba, Am. S. S. | Boston | Tela | 16 00 N. | 87 24 W. | 2 | 7a, 3 | 2 | 29.82 | SE. | E, 3 | SE. | SE, 6 | |
| Black Hawk, Am. S. S. | Rotterdam | New York | 49 53 N. | 7 42 W. | 3 | Noon, 3 | 3 | 29.65 | NW. | S, 4 | NW. | NW, 8 | S-NW. |
| Nashaba, Am. S. S. | New Orleans | Havre | 39 56 N. | 55 23 W. | 7 | 8a, 7 | 7 | 29.78 | | SSW, 8 | | SSW, 8 | |
| Katanga, Belg. S. S. | Lobito | Antwerp | 9 30 N. | 16 30 W. | 12 | 11p, 12 | 13 | 29.86 | WSW. | NW, 9 | WNW. | NW, 9 | WSW-NW-W. |
| Do | do | do | 14 39 N. | 17 57 W. | 16 | 11a, 14 | 16 | 29.90 | N. | N, 2 | NNE. | N, 7 | |
| Granada, Hond. S. S. | Key West | Frontera | 18 54 N. | 92 36 W. | 14 | 6a, 15 | 14 | 29.91 | SE. | ESE, 4 | SSE. | SSE, 6 | |
| Duivendrecht, Du. M. S. | Killingholm | Houston | 36 42 N. | 50 38 W. | 15 | Noon, 15 | 15 | 30.01 | SW. | SW, 8 | WSW. | SW, 8 | SW-W. |
| Emile Francqui, Belg. S. S. | Antwerp | New York | 47 26 N. | 36 02 W. | 15 | —, 16 | 16 | 29.24 | SW. | SW, 8 | NW. | NW, 8 | Steady. |
| Edam, Du. S.S. | Rotterdam | do | 47 24 N. | 36 16 W. | 15 | 9a, 16 | 16 | 29.24 | ENE. | WSW, 6 | NNW. | NNW, 9 | SSW-NW. |
| Collamer, Am. S. S. | New York | Havre | 48 38 N. | 28 46 W. | 16 | 10p, 16 | 17 | 29.34 | S. | SSW, 8 | W. | SSW, 9 | S-SW. |
| Boston City, Br. S. S. | Montreal | Cardiff | 51 55 N. | 10 15 W. | 19 | 8p, 20 | 21 | 29.80 | SW. | SW, 8 | W. | SW, 9 | Steady. |
| Blankaholm, Swed, M. S. | Gothenburg | Montreal | 59 12 N. | 26 10 W. | 20 | 8p, 20 | 21 | 29.29 | WNW. | NW, 8 | NNW. | NW, 9 | W-NW. |
| Coloradan, Am S. S. | Cristobal | Ponce | 13 06 N. | 74 45 W. | 25 | 4p, 25 | 26 | 29.80 | ENE. | E, 6 | E. | E, 6 | None. |
| West Kyska, Am. S. S. | Bremen | Tampa | 44 42 N. | 20 02 W. | 26 | 2p, 26 | 26 | 29.79 | SSE. | SSE, 7 | SSE. | SSE, 8 | SSE-W. |
| Mariana, Am. S. S. | Tampa | New Orleans | 27 47 N. | 83 41 W. | 29 | 9a, 29 | 29 | 29.80 | SE. | NW, 5 | S. | SE, 8 | SE-SW-N. |
| Tela, Hond. S. S. | Charleston | Philadelphia | 33 10 N. | 78 08 W. | 31 | 1a, 31 | 31 | 29.75 | NE. | NE, 9 | NW. | NE, 9 | NE-NW. |
| Capitaine Paul Lemerle, Fr. S. S. | Newport News | San Pedro Macoris. | 36 00 N. | 75 00 W. | 31 | Noon, 31 | 31 | [1]29.92 | NE. | NNE, 10 | N. | NNE, 10 | NE-NNW. |
| Gulfpride, Am. M. S. | Philadelphia | Port Arthur | 36 00 N. | 75 07 W. | 31 | Noon, 31 | 31 | 29.82 | NE. | NNW, — | N. | N, 8 | NE-NNW-N. |
| Peten, Am. S. S. | Habana | New York | 35 08 N. | 75 12 W. | 31 | Noon, 31 | 31 | 29.79 | W. | NW, 9 | NW. | NW, 9 | W-NW-NNE. |
| Coppename, Am. S. S. | Castilla | Boston | [2]36 08 N. | 74 06 W. | 31 | 2p, 31 | 31 | 29.40 | SSW. | N, — | NW. | NW, 9 | SSW-N-NW. |
| Santa Lucia, Am. S. S. | New York | Cristobal | 36 30 N. | 73 42 W. | 31 | 2p, 31 | 31 | 29.56 | | ENE, 4 | | NW, 8 | E-ENE-NW. |
| Turrialba, Am. S. S. | Boston | Habana | 37 42 N. | 70 50 W. | 31 | 7p, 31 | [3]1 | 29.64 | SSW. | SSW, 7 | WSW. | SW, 9 | E-SSW-SW. |
| Medea, Du. S. S. | New York | Inagua | 36 48 N. | 73 54 W. | 31 | 3p, 31 | 31 | 29.58 | E. | NNW, 11 | NNW. | NNW, 11 | E-NNW. |
| **NORTH PACIFIC OCEAN** | | | | | | | | | | | | | |
| Skramstad, Nor. M. S. | Yawata | Taruna, D. E. I. | [2]17 57 N. | 128 00 E. | 1 | 4p, 1 | 2 | 29.42 | ESE. | ESE, 8 | S. | ESE, 8 | |
| General Sherman, Am. S. S. | Yokohama | San Francisco | [2]47 51 N. | 178 08 W. | 2 | 2a, 2 | 1 | 29.74 | E. | SSE, 7 | SSE. | SSE, 9 | E-SSE. |
| Pierre L. D., Fr. M. S. | do | Saigon | 18 50 N. | 119 00 E. | 3 | 8a, 3 | 3 | 29.47 | NW. | WNW, 9 | WSW. | WNW, 9 | NW-SW. |
| Golden Mountain, Am. S. S. | do | San Francisco | 37 03 N. | 148 52 E. | 13 | Noon, 13 | 13 | 30.01 | SSE. | SSE, 6 | SSE. | S, 10 | None. |
| Birmingham City, Am. S. S. | Balboa | Los Angeles | 14 48 N. | 94 30 W. | 21 | 5a, 22 | 22 | 29.76 | N. | N, 8 | ESE. | N, 8 | |

[1] Barometer uncorrected.
[2] Position approximate.
[3] August.

## NORTH PACIFIC OCEAN, JULY 1937

By WILLIS E. HURD

*Atmospheric pressure.*—The Aleutian LOW was unusually well developed for July 1937, the average pressures at St. Paul, 29.72 inches, and Dutch Harbor, 29.79 inches, being, respectively, 0.12 and 0.15 inch below the normals of the month.

The greater part of the eastern two-thirds of the ocean was covered by an almost unbroken expanse of high pressure, with readings above normal at Tatoosh Island and Midway Island.

Low pressure prevailed in the southwestern tropics.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, July 1937, at selected stations*

| Station | Average pressure | Departure from normal | Highest | Date | Lowest | Date |
|---|---|---|---|---|---|---|
| | *Inches* | *Inch* | *Inches* | | *Inches* | |
| Point Barrow | 29.89 | −0.03 | 30.32 | 29 | 29.36 | 1 |
| Dutch Harbor | 29.79 | −.15 | 30.32 | 2 | 29.20 | 5 |
| St. Paul | 29.72 | −.12 | 30.30 | 2 | 29.10 | 5 |
| Kodiak | 29.87 | −.07 | 30.18 | 2 | 29.30 | 23 |
| Juneau | 30.05 | .00 | 30.25 | 11 | 29.73 | 3 |
| Tatoosh Island | 30.13 | +.08 | 30.32 | 6 | 29.88 | 17 |
| San Francisco | 29.93 | −.02 | 30.09 | 1 | 29.66 | 3 |
| Mazatlan | 29.88 | +.02 | 29.96 | 29 | 29.74 | 4 |
| Honolulu | 30.02 | .00 | 30.10 | 3 | 29.91 | 27 |
| Midway Island | 30.14 | +.03 | 30.22 | 28 | 30.06 | 30 |
| Guam | 29.80 | −.04 | 29.89 | 24 | 29.74 | 15 |
| Manila | 29.72 | −.02 | 29.86 | 4 | 29.56 | 2 |
| Hong Kong | 29.63 | −.02 | 29.84 | 8 | 29.41 | 29 |
| Naha | 29.71 | −.01 | 29.92 | 7, 8 | 29.41 | 22, 31 |
| Chichishima | 29.88 | +.03 | 30.03 | 6, 7 | 29.71 | 23 |
| Nemuro | 29.84 | ------- | 30.09 | 15, 17 | 29.56 | 11 |

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

*Cyclones and gales.*—No cyclones of importance occurred on middle and upper waters of the North Pacific in July 1937, although several LOWS traversed middle latitudes of the Far East and in higher latitudes of the ocean, resulting in the unusually deep Aleutian LOW this month. Over most of the eastern half of the sea area, except the extreme northern part, there were no disturbances of a cyclonic nature reported.

Indicative of the generally quiet nature of the weather in the Pacific extratropics is the fact that only two gales of moment are contained in the July ships' reports received. One is a south-southeast gale of force 9, with small depression of the barometer, experienced by the American steamer *General Sherman* near 48° N., 178° W., which occurred on the 1st; the other is a southerly gale of force 10, barometer 30.01, encountered by the American steamer *Golden Mountain*, near 37° N., 149° E., on the 13th.

*Tropical cyclones.*—Two tropical cyclones sufficiently energetic to be termed typhoons occurred in the Far East this month. The earlier, that of June 30–July 5, was mentioned in our report of last month as having caused hurricane velocities on the 30th between Luzon and the Marianas. The two storms are described in the subjoined report by Rev. Bernard F. Doucette, S. J., of the Philippine Weather Bureau. In further connection with the earlier typhoon, it may be added that on July 1, when the disturbance was east of northern Luzon, the Norwegian motorship *Skramstad* reported an east-southeast gale of force 8, barometer 29.42, near 18° N., 128° E., and on the 3d the French motorship *Pierre L. D.* had a west-northwest gale of force 9, barometer 29.47, near 18° N., 119° E.

In the American tropics a gale of force 8 from the north was experienced by the American steamer *Birmingham City* on the 22d on the lower waters of the Gulf of Tehuantepec. As there were no evidences of a cyclonic disturbance in the vicinity on that and on the following days, while an anticyclone over the United States was pressing into the Gulf of Mexico, the gale may undoubtedly be classed as one of the rare summer Tehuantepecers.

*Fog.*—Frequent fog was observed over the western half of the northern steamer routes on from a quarter to a third or more of the month. Some ships in upper east longitudes observed fog for 3 or more days in succession with only brief intermissions. The Norwegian motorship *Bonneville* reported being in fog for about 90 percent of the time from the 4th to 9th of July, between 41°30′ N., 151°20′ E., and 48°40′ N., 176°10′ E. The Dutch motorship *Djambi* had fog for most of the time from the 25th to the 31st, between 43°15′ N., 171°20′ E., and 43°23′ N., 147°10′ W. In upper west longitudes fog was less frequent and extensive, but occurred on from 1 to 5 or more days from the 180 meridian to the American coast. Cruisers in the Bering Sea reported fog from the 12th to 18th. Ships off the Oregon coast noted fog on 2 days, off the California coast on 4 days, and off the Lower California coast on 3 days.

## SMALL TROPICAL DISTURBANCE OF LATE JULY, 1937

By WILLIS E. HURD

*July 29–August 2.*—During July 29 radio reports from the eastern part of the Gulf of Mexico, off the Florida coast, indicated the existence of a minor tropical disturbance with gentle cyclonic circulation and slight barometric depression. A special report, however, later received by mail from the American steamer *Mariana*, going from Tampa toward New Orleans, showed that some storm development had occurred during the morning of the 29th. The ship reported a southeast gale of force 8, barometer 29.86, at 6:30 a. m., E. S. T., in latitude 27°41′ N., longitude 83°18′ W.; and at 8:30 a. m., a southwest wind of force 7, barometer 29.82, in 27°46′ N., 83°37′ W. At 9 a. m. the wind had changed to northwest, force 5, with lowest barometer, 29.80.

As the disturbance moved toward the coast, an estimated wind velocity of 40 to 45 miles an hour occurred at Egmont Key, at the entrance to Tampa Bay, at about 3 p. m., barometer 29.85. At that time the American steamship *Mundizie*, about 30 miles northwest of Egmont Key, as later reported by telephone, encountered a 60-mile gale from the southwest, barometer 29.62. The observed wind shifts on the vessel were from east through southeast and south to southwest. All evidence at hand shows that the strong winds of the disturbance on this day occupied only a very small area.

The disturbance crossed the west Florida coast north of Tampa late in the afternoon, moving northeastward. At Tampa the lowest barometer, 29.80, occurred at 6:25 p. m., and the maximum 5-minute wind velocity, 51 miles per hour from the southeast, at 6:34 p. m. At this station wind velocities exceeding 30 miles per hour lasted from 5 to 7 p. m. The heaviest rainfall, 8.88 inches in 24 hours, was reported at Clearwater.

In crossing Florida, according to Gordon E. Dunn, forecaster on duty at the Weather Bureau office at Jacksonville, "the storm speedily lost intensity in wind and rainfall and passed into the Atlantic near Daytona Beach about 4 a. m. (of the 30th) attended by about a 20-mile wind and very little rain." At 7 a. m., E. S. T., of the 30th the disturbance, then of mild force, was centered near 30° N. 80½° W. No gales were reported during the day, but at 1 a. m. (local time) of the 31st, the northbound Honduran

steamship *Tela*, in 33°10′ N., 78°08′ W., encountered a northeast gale of force 9, lowest barometer 29.75. Two hours later the wind at ship had diminished to force 6 from the northwest.

Between 6 and 7 a. m. (local time) the American steamer *Clare*, southbound, near 34°20′ N., 76°35′ to 76°40′ W., ran into northwest gales of force 9—extreme force 10. At 8:30 a. m. the ship, with little change in position, was evidently in the center of the cyclone, with lowest barometer 29.44, wind southeast, force 2.

At 7:30 a. m., E. S. T., the storm was centered a short distance southwest of Hatteras, continuing northeastward at a speed of about 20 miles an hour, which was almost two times its progressive rate on the 30th. During the forenoon its center passed very close to Hatteras, where the maximum wind velocity, from the northwest, was at the rate of 65 miles an hour, lowest barometer 29.53.

At 2 p. m., local time, of the 31st, the American steamer *Coppename*, Castilla to Boston, reported the lowest barometer, 29.40, observed in connection with the storm. This was in the approximate position 36°08′ N. 74°06′ W. The ship experienced heaviest wind at 4:30 p. m. with a gale from northwest, force 9, accompanied by squalls of greater intensity. The highest recorded wind force reported by any ship was 11, north-northwest, encountered on board the Dutch steamship *Medea*, at 3 p. m. (local time), lowest barometer 29.58, in 36°48′ N. 73°54′ W. The next highest, force 10, north-northeast, was experienced by the French steamer *Capitaine Paul Lemerle*, at local noon, in 36° N., 75° W., barometer 29.92 (uncorrected).

Other vessels that reported gale winds in the vicinity on the 31st were the American steamer *Peten*, northwest 9, lowest barometer 29.79, in 35°08′ N., 75°12′ W., at noon; the American motorship *Gulfpride*, north 8, lowest barometer 29.82, near 36° N., 75° W., at noon; the American steamship *Santa Lucia*, northwest 8, lowest barometer 29.56, in 36°30′ N. 73°42′ W., at 2 p. m.; the American steamer *Turrialba*, southwest 8–9, lowest barometer 29.64, near 38° N. 71° W., at 7 p. m.; and the British motorship *Wellfield*, southwest 9, barometer unrecorded, near 38° N. 68° W. The *Turrialba* and the *Wellfield* met diminishing gales which continued until 1 a. m. of August 1.

Thereafter, with abating intensity, the disturbance moved toward Nova Scotia, the coast of which it crossed late on August 1, and dissipated over the lower St. Lawrence Valley during the night of August 2–3.

The report of the forecaster, Mr. Dunn, at Jacksonville, said that, "except for some road washing at Clearwater and a slight fruit loss in Pinellas County, no damage resulted from the storm" in the Florida district.

As early as the character of the disturbance off the Florida west coast became known, storm warnings were issued at 5:30 p. m. of July 29 for the coast from Palmetto to Tarpon Springs. Thereafter, through the 31st, advisories or warnings were issued for the coast as far northward as the Virginia Capes.

## TYPHOONS AND DEPRESSIONS OVER THE FAR EAST, JULY 1937

By Rev. BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

*Typhoon, June 30–July 5, 1937.*—A low-pressure trough extending from the Philippines to the Mariana Islands, June 27 and the following days, finally manifested itself as a depression, June 30, about 550 miles in a northerly direction from Yap. As it moved westerly, it intensified and became a typhoon, the morning of July 2, about 200 miles east by south of Aparri. Its course threatened the whole of northern Luzon, until late in the afternoon, when it shifted to the northwest, the center then passing a short distance north of Aparri and, a few hours later, a short distance south of Calayan. After crossing the central part of the Balintang Channel, it continued its northwest course across the northern part of the China Sea, losing its strength when it approached the coast line of China, filling up a short time after entering the continent.

The intensity of the typhoon is well indicated by the observations made at Calayan. A relative calm was experienced there from 9 a. m. to shortly before 11 a. m. The absolute minimum occurred at 8:45 a. m., when 718.85 millimeters (28.301 inches) was recorded, with southeast winds, force 8. At Aparri, a few hours before, 739.81 millimeters (29.127 inches) was recorded with west winds, force 8 (July 3, 4:02 a. m.).

According to reports, only one life was lost in the Philippines due to the typhoon, when a man was reported killed near Baguio. In the China Sea, however, a fishing vessel from Formosa was driven southward by the northerly winds of the typhoon and foundered near Cabugao (latitude 17°50′ N., longitude 120°25′ E.).

Three of the crew were drowned and the seven remaining members swam to shore. The only other marine casualty reported was the S. S. *Ronsan Maru*, which took shelter in Port San Vicente, near Aparri, and was driven ashore by the strong winds. She was refloated after the storm had passed and was not injured to any appreciable extent, according to the newspaper reports.

*Typhoon, July 17–25, 1937.*—Pressure values at Guam and Yap were quite low July 17 and 18, so much so that it was certain something was developing over those regions. No definite center appeared, however, until the morning of July 19, when, about 360 miles east of north of Samar, there appeared a depression. It apparently had formed during the preceding night and was moving in a west-northwest direction. It had developed into a typhoon the next morning as it was inclining to the northwest. The morning of July 21 found it located over the eastern part of the Balintang Channel, gradually inclining to the north. Late that afternoon, it was definitely moving northeast, but on the 22nd it shifted to the north, passing about 60 miles east of Naha and then less than 50 miles west of Oshima, moving in a northerly direction. On July 25 it was approaching Kiu-Siu Island, the western part of which was crossed the next day, moving north-northeast. The typhoon was in the Sea of Japan, July 27, moving north-northeast, as this article was being prepared.

When the typhoon was moving toward the archipelago, July 19 and 20, the S. S. *Steel Traveler* and the S. S. *Tjimonoek* sent observations which definitely indicated the intensity of the storm.

On the morning of July 20, the center was nearer to these two ships than on any other day. At 5 a. m. the S. S. *Tjimonoek* reported from latitude 12°48′ N., longitude 128°00′ E. a barometer of 752.4 millimeters (29.622 inches) with west-northwest winds, force 4. The S. S. *Steel Navigator* at 8 a. m. of the same day had, in latitude 13°42′ N., longitude 127°36′ E., north-northwest winds force 5, and a pressure of 754.1 millimeters (29.689 inches). Both ships reported rainy weather with squalls.

At this period, the typhoon was not fully developed. When it reached the Balintang Channel, the stations of Luzon did not have pressures below 750 millimeters (29.528 inches), but there was a definite circulation evident and it was certain that a center, perhaps small, existed in the Pacific east of the archipelago. When the

typhoon had definitely recurved, it manifested its energy over the Eastern Sea and neighboring regions. Oshima, at noon, July 23, reported pressure as low as 739 millimeters (29.094 inches), Kagoshima had a value of 740 millimeters (29.134 inches) at noon of July 25, and Nagasaki at the same time had a value of 739 millimeters (29.094 inches). The typhoon appeared to be weakening when it took its course through the Sea of Japan, July 26 and 27.

## CLIMATOLOGICAL TABLES

### CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, July 1937*

[For description of tables and charts, see REVIEW, January, p. 29]

| Section | Temperature | | | | | | | | Precipitation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Section average | Departure from the normal | Monthly extremes | | | | | | Section average | Departure from the normal | Greatest monthly | | Least monthly | |
| | | | Station | Highest | Date | Station | Lowest | Date | | | Station | Amount | Station | Amount |
| | °F. | °F. | | °F. | | | °F. | | In. | In. | | In. | | In. |
| Alabama | 80.0 | −0.3 | 2 stations | 101 | [1] 15 | 2 stations | 49 | [1] 1 | 4.46 | −0.90 | Jackson Shoals | 9.04 | Fort Payne | 0.80 |
| Arizona | 81.9 | +.5 | Quartzsite | 121 | [1] 2 | Fort Defiance (near) | 36 | 11 | 1.68 | −.62 | Nogales | 5.60 | Mesa Expt. Station | .10 |
| Arkansas | 80.4 | −.1 | Booneville | 106 | 5 | Wynne | 52 | 1 | 3.71 | −.09 | St. Francis | 9.77 | Highland | .44 |
| California | 74.1 | +.5 | Cow Creek | 124 | 3 | Twin Lakes | 27 | [1] 18 | .11 | +.04 | Ellery Lake | 2.31 | 107 stations | .00 |
| Colorado | 69.7 | +2.6 | 2 stations | 109 | [1] 22 | Pearl | 29 | 21 | 1.83 | −.38 | Leadville | 8.70 | Malachite Ranger Station. | .06 |
| Florida | 81.2 | −.1 | Blountstown | 100 | 11 | Mason (near) | 60 | 24 | 6.92 | −.29 | Clearwater | 22.31 | Mason (near) | 2.43 |
| Georgia | 79.8 | −.3 | 3 stations | 101 | [1] 13 | Blairsville | 40 | 3 | 4.96 | −.77 | Quitman | 12.92 | Atlanta No. 2 | 1.00 |
| Idaho | 69.6 | +1.5 | Lapwai | 111 | 24 | 2 stations | 28 | [1] 6 | .97 | +.31 | Driggs | 4.10 | 2 stations | T |
| Illinois | 75.7 | −.7 | 2 stations | 100 | [1] 10 | Danville | 43 | 1 | 3.18 | −.07 | Havana | 10.95 | Rockford | .05 |
| Indiana | 74.6 | −1.1 | 4 stations | 101 | [1] 8 | 2 stations | 40 | 1 | 3.67 | +.35 | Crawfordville | 8.38 | Salem | .82 |
| Iowa | 75.9 | +1.3 | Atlantic | 107 | 7 | 4 stations | 46 | [1] 26 | 2.63 | −1.03 | Riverton (near) | 8.35 | Forest City | .13 |
| Kansas | 81.7 | +2.7 | 2 stations | 113 | 5 | 2 stations | 52 | [1] 2 | 3.14 | −.06 | Howard | 14.86 | Tribune | .54 |
| Kentucky | 75.6 | −1.5 | Bowling Green | 102 | [1] 15 | Cutbank | 41 | 2 | 3.04 | −1.07 | Glasgow | 6.71 | Irvington | .76 |
| Louisiana | 82.0 | +.2 | Minden | 102 | 5 | Tallulah | 54 | 1 | 4.66 | −1.48 | Cheneyville | 9.77 | Burrwood | .59 |
| Maryland-Delaware | 74.9 | −.3 | Annapolis, Md | 100 | 9 | 2 stations | 39 | 28 | 3.82 | −.40 | Parkton, Md | 7.29 | Keedysville, Md | 1.29 |
| Michigan | 70.1 | +1.0 | Baldwin | 99 | 11 | Vanderbilt | 33 | 3 | 3.53 | +.63 | Monroe | 8.46 | Webber Dam | .78 |
| Minnesota | 72.3 | +2.3 | Beardsley | 105 | 6 | Meadowland | 37 | 1 | 3.11 | −.18 | Baudette | 12.50 | Winona | .13 |
| Mississippi | 80.5 | −.6 | Aberdeen | 102 | 17 | Eupora | 49 | 1 | 3.46 | −1.56 | Cleveland | 6.89 | Dlo | 1.35 |
| Missouri | 77.9 | −.1 | Lamar | 105 | 5 | Greenville | 45 | 1 | 4.06 | +.37 | Fisk | 10.90 | St. Louis | .67 |
| Montana | 69.8 | +2.9 | Medicine Lake | 117 | 5 | Birch Creek Camp | 27 | 15 | 1.70 | +.23 | Scobey | 4.90 | Browning | .23 |
| Nebraska | 78.5 | +3.4 | North Loup | 113 | 8 | Gordon | 43 | 25 | 2.70 | −.45 | Ewing | 10.37 | Bridgeport | .32 |
| Nevada | 75.3 | +2.8 | Logandale | 118 | 4 | San Jacinto | 33 | 8 | .67 | +.29 | McGill | 3.03 | 4 stations | .00 |
| New England | 70.6 | +1.5 | Waterbury, Conn | 102 | 9 | Somerset, Vt | 39 | 19 | 2.90 | −.78 | West Lebanon, N. H. | 7.69 | East Wareham, Mass. | .07 |
| New Jersey | 74.6 | +.9 | Charlotteburg | 103 | 10 | 2 stations | 43 | 2 | 2.83 | −1.96 | Long Valley | 5.98 | Camden | .58 |
| New Mexico | 73.2 | +.9 | Hagerman | 108 | 30 | Elizabethtown | 32 | 22 | 1.46 | −1.06 | Corona | 5.52 | Loving | .00 |
| New York | 71.0 | +1.3 | West Point | 102 | 8 | Allegany State Park | 38 | 2 | 3.19 | −.70 | North Lake | 9.33 | Waterloo | .59 |
| North Carolina | 76.7 | −.3 | Lumberton | 104 | 10 | Mount Mitchell | 36 | 1 | 6.26 | +.41 | Beaufort | 19.91 | Monroe | 1.91 |
| North Dakota | 71.7 | +2.9 | 3 stations | 111 | 5 | 2 stations | 40 | [1] 17 | 2.93 | +.51 | Grafton | 9.48 | Granville | .78 |
| Ohio | 73.2 | −.5 | Gallipolis (near) | 102 | 9 | Kenton (near) | 41 | 1 | 4.27 | +.48 | Alliance | 10.25 | Chilo | 1.53 |
| Oklahoma | 84.2 | +2.5 | 2 stations | 111 | [1] 5 | Hooker | 51 | 10 | 2.01 | −.85 | Grove | 7.31 | Carnegie | .02 |
| Oregon | 67.3 | +.8 | do | 106 | [1] 4 | Austin | 20 | 8 | .35 | −.06 | Spray | 2.50 | 4 stations | .00 |
| Pennsylvania | 72.4 | +.2 | do | 101 | [1] 8 | Somerset | 37 | 28 | 4.47 | +.19 | Uniontown | 8.69 | Ansonia | .97 |
| South Carolina | 79.5 | −.4 | Walterboro | 103 | 14 | Long Creek (near) | 45 | 2 | 5.09 | −.72 | Landrum | 9.91 | Calhoun Falls | .59 |
| South Dakota | 76.0 | +3.0 | Academy | 112 | 6 | Kennebec | 45 | 15 | 2.83 | +.37 | Vale | 9.27 | Geddes | .36 |
| Tennessee | 76.9 | −.8 | Etowah | 102 | 15 | Crossville | 42 | 1 | 4.24 | −.21 | Wildersville | 7.55 | Worsham | 1.90 |
| Texas | 83.9 | +.9 | Clarendon | 113 | 14 | 2 stations | 55 | [1] 6 | 1.98 | −.65 | Comanche | 7.59 | 2 stations | .00 |
| Utah | 72.2 | +.5 | St. George | 110 | 3 | Thistle | 36 | 3 | 1.89 | +.96 | Mount Baldy Ranger Station. | 4.35 | Leeds (near) | T |
| Virginia | 74.5 | −.9 | 4 stations | 101 | [1] 10 | Mountain Lake | 37 | 2 | 4.88 | +.38 | Martinsville | 9.27 | Radford | 1.89 |
| Washington | 67.4 | +1.1 | Wahluke (near) | 110 | 24 | Stockdill Ranch | 30 | 31 | .38 | −.28 | Laurier | 2.18 | 7 stations | .00 |
| West Virginia | 72.4 | −.7 | Martinsburg | 101 | 16 | Bayard | 37 | 28 | 3.96 | −.62 | Richwood | 7.96 | Kearnysville | 1.07 |
| Wisconsin | 72.2 | +2.1 | 7 stations | 101 | [1] 7 | Coddington | 32 | 27 | 2.14 | −1.38 | Flambeau Reservoir | 7.63 | Mather | .05 |
| Wyoming | 66.9 | +1.3 | Chugwater | 110 | 5 | 2 stations | 30 | [1] 15 | 2.86 | +1.52 | Ervay | 7.87 | Cody | .47 |
| Alaska (June) | 54.1 | +1.6 | Nenana | 94 | 18 | do | 22 | [1] 4 | 1.04 | +.41 | Cordova | 15.77 | 3 stations | T |
| Hawaii | 74.5 | +.2 | Kaanapali | 94 | [1] 12 | Kanalohuluhulu | 47 | 10 | 9.12 | +2.95 | Puosakamoa No. 2 | 52.00 | do | .00 |
| Puerto Rico | 79.3 | +1.0 | Juana Diaz | 100 | 2 | Garzas | 58 | 9 | 5.09 | −1.15 | Bayaney | 12.67 | Mona Island | .00 |

[1] Other dates also.

## TABLE 2.—*Climatological data for Weather Bureau stations, July 1937*

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

| District and station | Elevation of instruments: Barometer above sea level | Elevation of instruments: Thermometer above ground | Elevation of instruments: Anemometer above ground | Pressure: Station, reduced to mean of 24 hours | Pressure: Sea level, reduced to mean of 24 hours | Pressure: Departure from normal | Temperature of the air: Mean max. + mean min. ÷ 2 | Temperature of the air: Departure from normal | Temperature of the air: Maximum | Temperature of the air: Date | Temperature of the air: Mean maximum | Temperature of the air: Minimum | Temperature of the air: Date | Temperature of the air: Mean minimum | Temperature of the air: Greatest daily range | Mean wet thermometer | Mean temperature of the dew-point | Mean relative humidity | Precipitation: Total | Precipitation: Departure from normal | Precipitation: Days with 0.01 inch or more | Wind: Average hourly velocity | Wind: Prevailing direction | Wind: Maximum velocity: Miles per hour | Wind: Maximum velocity: Direction | Wind: Maximum velocity: Date | Clear days | Partly cloudy days | Cloudy days | Average cloudiness, tenths | Total snowfall | Snow, sleet, and ice on ground at end of month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Ft.* | *Ft.* | *Ft.* | *In.* | *In.* | *In.* | °F. | °F. | °F. | | °F. | °F. | | °F. | °F. | °F. | °F. | % | *In.* | *In.* | | *Miles* | | | | | | | | *0–10* | *In.* | *In.* |
| ***New England*** | | | | | | | **70.6** | **+1.7** | | | | | | | | | | **77** | **2.21** | **−1.3** | | | | | | | | | | **5.2** | | |
| Eastport | 76 | 67 | 85 | 29.87 | 29.95 | +0.02 | 63.1 | +2.7 | 87 | 8 | 73 | 49 | 1 | 54 | 36 | 59 | 56 | 81 | 0.75 | −2.3 | 5 | 7.3 | sw. | 21 | ne. | 13 | 7 | 10 | 14 | 6.1 | 0.0 | 0.0 |
| Greenville, Maine | 1,070 | 6 | 40 | 28.81 | 29.95 | ..... | 67.1 | ..... | 86 | 23 | 78 | 49 | 2 | 57 | 32 | 62 | 59 | ... | 3.29 | ..... | 11 | 3.0 | n. | 12 | ... | ... | 6 | 6 | 13 | 12 | ..... | .0 | .0 |
| Portland, Maine | 103 | 82 | 117 | 29.83 | 29.95 | .00 | 70.6 | +2.5 | 98 | 8 | 78 | 56 | 2 | 63 | 30 | 64 | 60 | 71 | .95 | −2.3 | 6 | 7.4 | s. | 25 | w. | 24 | 16 | 14 | 1 | 3.5 | .0 | .0 |
| Concord | 289 | 60 | ..... | 29.64 | 29.95 | −.01 | 71.2 | +2.7 | 95 | 8 | 83 | 49 | 14 | 59 | 34 | ... | ... | ... | 2.76 | −.8 | 7 | ..... | nw. | ... | ... | ... | 12 | 14 | 5 | ..... | .0 | .0 |
| Burlington | 403 | 11 | 48 | 29.50 | 29.92 | −.02 | 71.0 | +.7 | 92 | 23 | 81 | 53 | 19 | 61 | 28 | 64 | 60 | 72 | 2.97 | −.5 | 8 | 7.6 | s. | 15 | s. | 15 | 11 | 8 | 12 | 5.4 | .0 | .0 |
| Northfield | 876 | 12 | 60 | 29.03 | 29.95 | +.01 | 67.6 | +1.7 | 91 | 8 | 80 | 46 | 19 | 55 | 35 | 62 | 60 | 79 | 4.75 | +1.2 | 11 | 6.2 | s. | 21 | sw. | 30 | 7 | 15 | 9 | 5.7 | .0 | .0 |
| Boston [1] | 29 | 31 | 50 | 29.92 | 29.96 | .00 | 73.2 | +1.5 | 99 | 8 | 82 | 55 | 14 | 65 | 27 | 65 | 62 | 71 | 1.17 | −2.3 | 8 | 8.5 | sw. | 37 | n. | 9 | 9 | 13 | 9 | 5.5 | .0 | .0 |
| Nantucket | 12 | 14 | 90 | 29.96 | 29.97 | −.01 | 68.6 | +.8 | 86 | 8 | 75 | 58 | 23 | 62 | 20 | 65 | 64 | 90 | 1.26 | −1.6 | 8 | 11.3 | sw. | 30 | ne. | 13 | 12 | 7 | 12 | 5.5 | .0 | .0 |
| Block Island | 26 | 11 | 46 | 29.94 | 29.97 | .00 | 69.7 | +1.3 | 88 | 10 | 76 | 58 | 14 | 64 | 19 | 66 | 65 | 89 | 1.22 | −1.9 | 7 | 11.1 | sw. | 27 | sw. | 16 | 8 | 16 | 7 | 5.3 | .0 | .0 |
| Providence | 159 | 215 | 251 | 29.80 | 29.97 | .00 | 73.5 | +.1 | 97 | 8 | 83 | 53 | 14 | 64 | 31 | 66 | 62 | 69 | 1.16 | −2.1 | 7 | 9.0 | nw. | 27 | s. | 26 | 14 | 10 | 7 | 4.8 | .0 | .0 |
| Hartford | 159 | 66 | 100 | 29.80 | 29.96 | −.01 | 73.8 | +2.2 | 97 | 9 | 84 | 54 | 4 | 64 | 29 | ... | ... | ... | 3.11 | −1.3 | 7 | 6.8 | s. | 25 | sw. | 26 | 14 | 12 | 5 | 4.5 | .0 | .0 |
| New Haven | 106 | 74 | 153 | 29.86 | 29.98 | +.01 | 73.8 | +2.0 | 98 | 9 | 82 | 55 | 2 | 65 | 25 | 66 | 63 | 71 | 4.21 | −.1 | 8 | 7.5 | s. | 30 | sw. | 26 | 8 | 14 | 9 | 5.4 | .0 | .0 |
| ***Middle Atlantic States*** | | | | | | | **75.6** | **+0.7** | | | | | | | | | | **72** | **3.41** | **−0.9** | | | | | | | | | | **5.5** | | |
| Albany | 97 | 97 | 112 | 29.85 | 29.95 | −.01 | 74.4 | +1.8 | 98 | 8 | 85 | 55 | 2 | 64 | 31 | 66 | 62 | 69 | 4.35 | +.9 | 11 | 6.8 | s. | 24 | sw. | 26 | 11 | 11 | 9 | 5.2 | .0 | .0 |
| Binghamton | 871 | 57 | 79 | 29.07 | 29.98 | +.01 | 72.1 | +2.1 | 95 | 8 | 84 | 49 | 2 | 61 | 34 | ... | ... | ... | 1.33 | −2.4 | 10 | 5.3 | e. | 18 | sw. | 15 | 6 | 10 | 15 | 6.7 | .0 | .0 |
| New York | 314 | 415 | 454 | 29.64 | 29.97 | −.01 | 75.4 | +1.6 | 96 | 10 | 83 | 58 | 2 | 68 | 21 | 67 | 63 | 70 | 4.41 | +.2 | 8 | 11.1 | w. | 49 | nw. | 26 | 11 | 8 | 12 | 5.3 | .0 | .0 |
| Harrisburg | 374 | 94 | 104 | 29.58 | 29.97 | −.01 | 74.8 | .0 | 96 | 8 | 84 | 55 | 2 | 66 | 25 | 66 | 62 | 69 | 4.83 | +1.0 | 11 | 6.4 | w. | 24 | nw. | 16 | 8 | 18 | 5 | 5.2 | .0 | .0 |
| Philadelphia | 114 | 174 | 367 | 29.87 | 29.99 | +.01 | 77.1 | +.9 | 98 | 10 | 85 | 59 | 1 | 69 | 26 | 68 | 63 | 66 | 1.16 | −3.0 | 11 | 10.3 | sw. | 29 | sw. | 26 | 6 | 16 | 9 | 5.7 | .0 | .0 |
| Reading | 323 | 283 | 306 | 29.63 | 29.97 | ..... | 74.8 | −.7 | 96 | 9 | 84 | 55 | 2 | 66 | 24 | 66 | 62 | 68 | 4.10 | −.2 | 15 | 8.7 | nw. | 49 | e. | 23 | 7 | 20 | 4 | 5.5 | .0 | .0 |
| Scranton | 805 | 72 | 104 | 29.13 | 29.98 | .00 | 73.0 | +1.3 | 94 | 10 | 84 | 49 | 2 | 62 | 35 | 65 | 61 | 70 | 2.67 | −1.4 | 11 | 5.3 | n. | 19 | sw. | 26 | 6 | 17 | 8 | 5.6 | .0 | .0 |
| Atlantic City | 52 | 37 | 172 | 29.92 | 29.97 | −.01 | 75.8 | +3.7 | 97 | 16 | 82 | 61 | 22 | 70 | 21 | 70 | 67 | 77 | .96 | −3.0 | 8 | 13.0 | s. | 36 | se. | 26 | 10 | 14 | 7 | 5.2 | .0 | .0 |
| Sandy Hook | 22 | 10 | 57 | 29.95 | 29.97 | ..... | 75.4 | +1.9 | 98 | 10 | 82 | 62 | 2 | 68 | 23 | 68 | 65 | 75 | 1.71 | −3.4 | 8 | 10.4 | w. | 32 | nw. | 26 | 14 | 5 | 12 | 4.7 | .0 | .0 |
| Trenton | 190 | 88 | 106 | 29.77 | 29.97 | ..... | 75.8 | +1.3 | 99 | 9 | 85 | 56 | 2 | 66 | 27 | 67 | 63 | 69 | 1.84 | −2.1 | 9 | 7.7 | s. | 26 | s. | 26 | 10 | 12 | 9 | 5.4 | .0 | .0 |
| Baltimore | 123 | 100 | 215 | 29.85 | 29.97 | −.01 | 78.3 | +1.1 | 97 | 9 | 86 | 59 | 1 | 70 | 22 | 69 | 65 | 66 | 3.81 | −.8 | 11 | 9.3 | sw. | 37 | ne. | 31 | 7 | 17 | 7 | 5.2 | .0 | .0 |
| Washington | 112 | 62 | 85 | 29.86 | 29.97 | −.03 | 77.2 | +.4 | 96 | 16 | 86 | 58 | 1 | 68 | 24 | 69 | 66 | 72 | 3.67 | −1.0 | 12 | 5.9 | nw. | 24 | nw. | 11 | 8 | 17 | 6 | 5.4 | .0 | .0 |
| Cape Henry | 18 | 8 | 54 | 29.97 | 29.99 | ..... | 78.2 | +.7 | 95 | 16 | 85 | 62 | 1 | 72 | 25 | 72 | 70 | 79 | 3.49 | −1.9 | 13 | 9.8 | sw. | 35 | ne. | 20 | 12 | 10 | 9 | 5.2 | .0 | .0 |
| Lynchburg | 686 | 148 | 184 | 29.30 | 30.03 | +.02 | 75.8 | −1.7 | 98 | 9 | 86 | 57 | 2 | 66 | 29 | 68 | 65 | 74 | 5.97 | +1.8 | 12 | 5.9 | nw. | 36 | nw. | 10 | 7 | 15 | 9 | 5.4 | .0 | .0 |
| Norfolk | 91 | 80 | 125 | 29.90 | 30.00 | .00 | 79.4 | +.7 | 98 | 16 | 87 | 63 | 1 | 72 | 26 | 72 | 69 | 76 | 5.69 | −.1 | 13 | 7.6 | w. | 31 | nw. | 17 | 7 | 11 | 13 | 6.4 | .0 | .0 |
| Richmond | 144 | 11 | 52 | 29.86 | 30.00 | −.01 | 77.0 | −1.5 | 97 | 16 | 86 | 58 | 2 | 68 | 26 | 70 | 68 | 79 | 6.00 | +1.3 | 14 | 6.3 | sw. | 24 | sw. | 26 | 9 | 12 | 10 | 5.4 | .0 | .0 |
| Wytheville | 2,304 | 49 | 55 | ..... | 30.04 | +.03 | 70.5 | −2.1 | 91 | 9 | 81 | 50 | 2 | 60 | 29 | ... | ... | 78 | 1.98 | −2.0 | 18 | 5.2 | w. | 20 | sw. | 16 | 7 | 11 | 13 | ..... | .0 | .0 |
| ***South Atlantic States*** | | | | | | | **79.5** | **+0.3** | | | | | | | | | | **79** | **6.49** | **+0.7** | | | | | | | | | | **5.9** | | |
| Asheville | 2,253 | 89 | 104 | 27.75 | 30.03 | +.01 | 73.3 | +1.6 | 93 | 15 | 84 | 49 | 1 | 62 | 36 | 65 | 62 | 77 | 4.18 | −.1 | 14 | 6.0 | nw. | 21 | sw. | 11 | 7 | 17 | 7 | 5.4 | .0 | .0 |
| Charlotte | 779 | 63 | 86 | 29.20 | 30.02 | .00 | 79.0 | +.6 | 98 | 16 | 89 | 61 | 2 | 69 | 27 | 70 | 67 | 74 | 4.19 | −.9 | 11 | 6.1 | sw. | 21 | se. | 25 | 5 | 13 | 13 | 6.2 | .0 | .0 |
| Greensboro | 886 | 6 | 56 | 29.08 | 30.02 | ..... | 76.1 | ..... | 96 | 16 | 87 | 55 | 3 | 66 | 32 | 68 | 66 | 79 | 2.75 | ..... | 15 | 6.6 | sw. | 34 | sw. | 16 | 9 | 15 | 7 | 5.5 | .0 | .0 |
| Hatteras | 11 | 5 | 50 | 29.99 | 30.00 | −.01 | 78.7 | +.5 | 89 | 10 | 83 | 69 | 1 | 74 | 15 | 75 | 73 | 84 | 10.94 | +5.4 | 19 | 11.3 | sw. | 65 | nw. | 31 | 6 | 13 | 12 | 6.0 | .0 | .0 |
| Raleigh | 376 | 103 | 146 | 29.60 | 29.99 | −.03 | 78.6 | −.2 | 100 | 16 | 88 | 61 | 1 | 69 | 27 | 71 | 68 | 78 | 4.33 | −1.1 | 11 | 7.1 | sw. | 40 | w. | 17 | 6 | 19 | 6 | 5.2 | .0 | .0 |
| Wilmington | 72 | 73 | 107 | 29.94 | 30.01 | .00 | 79.8 | +.7 | 95 | 11 | 88 | 66 | 1 | 72 | 22 | 74 | 72 | 83 | 6.45 | −.7 | 17 | 8.5 | sw. | 30 | nw. | 13 | 5 | 20 | 6 | 6.0 | .0 | .0 |
| Charleston | 48 | 11 | 92 | 29.98 | 30.03 | .00 | 81.0 | −.4 | 96 | 16 | 88 | 67 | 22 | 74 | 23 | 75 | 73 | 80 | 9.62 | +2.7 | 14 | 8.7 | s. | 29 | ne. | 12 | 6 | 17 | 14 | 7.1 | .0 | .0 |
| Columbia, S. C | 347 | 70 | 91 | 29.65 | 30.02 | .00 | 80.5 | −.4 | 100 | 16 | 90 | 62 | 2 | 70 | 32 | 71 | 68 | 75 | 4.79 | −.6 | 7 | 6.9 | s. | 24 | w. | 4 | 10 | 17 | 4 | 4.8 | .0 | .0 |
| Greenville, S. C | 1,039 | 139 | ..... | ... | ... | ... | 79.0 | +2.1 | 98 | 16 | 89 | 60 | 1 | 69 | 24 | ... | ... | ... | 3.77 | −1.6 | 9 | ..... | w. | ... | ... | ... | 13 | 11 | 7 | ..... | .0 | .0 |
| Augusta | 182 | 62 | 77 | 29.81 | 30.00 | −.02 | 81.2 | −.1 | 99 | 14 | 91 | 62 | 3 | 71 | 31 | 72 | 69 | 76 | 4.54 | −.8 | 13 | 5.5 | s. | 20 | w. | 17 | 3 | 18 | 10 | 6.1 | .0 | .0 |
| Savannah | 65 | 73 | 152 | 29.96 | 30.03 | .00 | 81.3 | −.2 | 97 | 13 | 90 | 68 | 5 | 73 | 25 | 74 | 72 | 82 | 8.91 | +2.3 | 15 | 9.1 | sw. | 30 | ne. | 14 | 3 | 17 | 11 | 6.2 | .0 | .0 |
| Jacksonville | 43 | 86 | 110 | 30.00 | 30.05 | +.02 | 81.6 | −.5 | 96 | 12 | 90 | 69 | 23 | 74 | 25 | 74 | 72 | 82 | 9.69 | +3.0 | 17 | 7.2 | sw. | 23 | sw. | 23 | 5 | 12 | 14 | 6.4 | .0 | .0 |
| ***Florida Peninsula*** | | | | | | | **81.8** | **+0.1** | | | | | | | | | | **78** | **5.69** | **+0.6** | | | | | | | | | | **6.1** | | |
| Key West | 22 | 10 | 64 | 30.02 | 30.04 | +.01 | 82.9 | −.6 | 91 | 30 | 88 | 70 | 1 | 78 | 19 | 77 | 75 | 78 | 4.11 | +.8 | 10 | 8.4 | e. | 26 | s. | 1 | 7 | 12 | 12 | 5.7 | .0 | .0 |
| Miami | 25 | 124 | 168 | 30.03 | 30.06 | +.02 | 81.8 | +.8 | 90 | 21 | 87 | 72 | 2 | 76 | 16 | 75 | 73 | 75 | 5.70 | +.3 | 17 | 8.3 | se. | 40 | s. | 1 | 7 | 12 | 12 | 5.9 | .0 | .0 |
| Tampa | 35 | 88 | 197 | 30.02 | 30.06 | +.02 | 82.0 | +.8 | 95 | 5 | 89 | 70 | 2 | 75 | 20 | 75 | 73 | 80 | 8.32 | +.4 | 18 | 9.1 | w. | 51 | se. | 29 | 4 | 17 | 10 | 6.6 | .0 | .0 |
| Titusville | 43 | 5 | 36 | 30.00 | 30.05 | ..... | 80.6 | −.6 | 95 | 13 | 90 | 65 | 5 | 71 | 26 | 74 | 73 | ... | 4.64 | +1.0 | 13 | ..... | se. | ... | ... | ... | 3 | 14 | 14 | ..... | .0 | .0 |
| ***East Gulf States*** | | | | | | | **80.8** | **0.0** | | | | | | | | | | **73** | **3.88** | **−1.8** | | | | | | | | | | **5.6** | | |
| Atlanta [1] | 976 | 5 | 53 | 29.01 | 30.00 | −.02 | 79.6 | +1.5 | 97 | 16 | 90 | 58 | 2 | 70 | 26 | 70 | 66 | 70 | 2.30 | −2.4 | 7 | 7.0 | nw. | 29 | sw. | 4 | 3 | 18 | 10 | 6.1 | .0 | .0 |
| Macon | 370 | 79 | 87 | 29.63 | 30.02 | .00 | 80.4 | −.8 | 97 | 11 | 90 | 58 | 2 | 71 | 28 | 72 | 68 | 73 | 4.71 | .0 | 14 | 6.1 | sw. | 22 | nw. | 4 | 5 | 19 | 7 | 6.2 | .0 | .0 |
| Thomasville | 273 | 49 | 58 | 29.76 | 30.03 | .00 | 80.7 | −1.1 | 95 | 11 | 91 | 66 | 31 | 71 | 27 | 74 | 72 | ... | 5.49 | −1.2 | 14 | ..... | sw. | ... | ... | ... | ... | ... | ... | ..... | .0 | .0 |
| Apalachicola | 35 | 11 | ..... | 30.01 | 30.04 | ..... | 81.8 | +.1 | 94 | 12 | 88 | 73 | 23 | 75 | 18 | 76 | 73 | 77 | 2.95 | −4.8 | 15 | 6.6 | w. | 26 | se. | 26 | 4 | 16 | 11 | 6.4 | .0 | .0 |
| Pensacola | 56 | 149 | 185 | 29.98 | 30.04 | +.03 | 80.8 | −.2 | 93 | 29 | 87 | 68 | 6 | 75 | 19 | 74 | 72 | 76 | 3.50 | −2.3 | 9 | 9.8 | sw. | 38 | sw. | 23 | 12 | 15 | 4 | 4.5 | .0 | .0 |
| Anniston | 741 | 9 | ..... | ... | ... | ... | 77.6 | −.3 | 95 | 16 | 88 | 53 | 2 | 67 | 33 | ... | ... | ... | 6.47 | +1.3 | 12 | ..... | w. | ... | ... | ... | 19 | 8 | 4 | ..... | .0 | .0 |
| Birmingham | 700 | 11 | 48 | 29.27 | 30.02 | +.01 | 79.7 | −.5 | 96 | 31 | 90 | 58 | 1 | 69 | 28 | 70 | 66 | 71 | 4.11 | −1.1 | 10 | 5.6 | s. | 26 | s. | 4 | 12 | 14 | 5 | 4.8 | .0 | .0 |
| Mobile | 57 | 86 | 161 | 29.97 | 30.03 | +.02 | 81.9 | +.5 | 94 | 30 | 91 | 67 | 2 | 73 | 24 | 74 | 71 | 74 | 7.27 | +.4 | 7 | 7.7 | sw. | 38 | nw. | 6 | 7 | 17 | 7 | 5.7 | .0 | .0 |
| Montgomery | 218 | 92 | 105 | 29.79 | 30.04 | +.02 | 81.4 | −.3 | 96 | 31 | 91 | 65 | 2 | 72 | 24 | 72 | 69 | 74 | 2.17 | −2.7 | 10 | 6.4 | sw. | 27 | w. | 31 | 8 | 17 | 6 | 5.2 | .0 | .0 |
| Meridian | 375 | 67 | 92 | 29.63 | 30.02 | .00 | 80.6 | +.2 | 96 | 31 | 92 | 61 | 2 | 69 | 30 | 71 | 67 | 71 | 2.68 | −2.2 | 10 | 5.2 | sw. | 21 | n. | 4 | 14 | 9 | 8 | 4.8 | .0 | .0 |
| Vicksburg | 247 | 82 | 102 | 29.76 | 30.02 | +.02 | 81.0 | −.3 | 95 | 3 | 89 | 65 | 1 | 73 | 23 | 73 | 70 | 74 | 1.57 | −3.0 | 4 | 7.2 | sw. | 21 | nw. | 21 | 7 | 13 | 11 | 5.9 | .0 | .0 |
| New Orleans | 53 | 76 | 84 | 29.99 | 30.04 | +.04 | 83.8 | +1.4 | 95 | 27 | 91 | 71 | 7 | 76 | 18 | 75 | 72 | 74 | 3.38 | −3.0 | 13 | 5.5 | sw. | 27 | ne. | 5 | 2 | 21 | 8 | 5.9 | .0 | .0 |
| Port Eads, La | 9 | 4 | 35 | ..... | ..... | ..... | 83.6 | ..... | 93 | 15 | 90 | 72 | 7 | 77 | 19 | ... | ... | ... | 3.07 | ..... | 11 | 7.6 | s. | 30 | sw. | 19 | 18 | 11 | 2 | ..... | .0 | .0 |
| ***West Gulf States*** | | | | | | | **83.0** | **+0.4** | | | | | | | | | | **71** | **2.50** | **−0.8** | | | | | | | | | | **4.5** | | |
| Shreveport | 249 | 92 | 227 | 29.73 | 29.99 | +.01 | 83.6 | +.4 | 100 | 5 | 93 | 68 | 1 | 74 | 26 | 74 | 70 | 71 | 1.42 | −2.1 | 7 | 9.2 | sw. | 28 | s. | 11 | 10 | 10 | 11 | 5.3 | .0 | .0 |
| Bentonville | 1,303 | 12 | 38 | 28.58 | 29.90 | −.07 | 78.6 | +.1 | 99 | 5 | 89 | 59 | 26 | 68 | 31 | ... | ... | ... | 7.10 | +2.8 | 7 | 5.7 | sw. | 25 | sw. | 5 | 8 | 17 | 6 | ..... | .0 | .0 |
| Fort Smith | 457 | 79 | 94 | 29.48 | 29.95 | −.02 | 83.0 | +1.5 | 100 | 5 | 93 | 66 | 1 | 73 | 32 | 72 | 67 | 63 | 3.24 | −.1 | 8 | 7.5 | e. | 24 | sw. | 6 | 10 | 17 | 4 | 4.7 | .0 | .0 |
| Little Rock | 357 | 94 | 102 | 29.62 | 29.99 | .00 | 80.6 | −.3 | 95 | 3 | 90 | 66 | 1 | 72 | 24 | 72 | 68 | 68 | 1.62 | −1.9 | 9 | 7.3 | sw. | 34 | w. | 5 | 8 | 14 | 9 | 5.8 | .0 | .0 |
| Austin | 605 | 68 | 90 | 29.34 | 29.96 | ..... | 84.7 | +.7 | 100 | 21 | 95 | 69 | 8 | 75 | 27 | 73 | 68 | 66 | .69 | −1.6 | 4 | 8.1 | s. | 24 | s. | 8 | 18 | 11 | 2 | 3.4 | .0 | .0 |
| Brownsville | 57 | 88 | 96 | 29.90 | 29.96 | ..... | 82.2 | −1.4 | 94 | 1 | 89 | 68 | 7 | 76 | 18 | 76 | 74 | 84 | 3.81 | +1.8 | 11 | 10.1 | se. | 26 | se. | 3 | 14 | 9 | 8 | 4.7 | .0 | .0 |
| Corpus Christi | 20 | 11 | 78 | 29.95 | 29.97 | +.01 | 82.8 | +.1 | 93 | 30 | 88 | 67 | 8 | 77 | 17 | 76 | 74 | 80 | 2.07 | +.5 | 11 | 12.1 | s. | 31 | se. | 8 | 16 | 8 | 7 | 4.2 | .0 | .0 |
| Dallas | 512 | 720 | 227 | 29.42 | 29.95 | ..... | 84.3 | ..... | 100 | 28 | 94 | 70 | 9 | 75 | 25 | 72 | 66 | 61 | 2.22 | −.6 | 5 | 10.0 | s. | 38 | w. | 20 | 13 | 9 | 9 | 4.4 | .0 | .0 |
| Fort Worth | 679 | 92 | 110 | 29.27 | 29.96 | .00 | 85.0 | +1.4 | 101 | 28 | 95 | 69 | 1 | 75 | 27 | ... | ... | ... | 1.93 | −.7 | 4 | 9.9 | s. | 25 | nw. | 7 | 19 | 10 | 2 | 2.9 | .0 | .0 |
| Galveston | 54 | 106 | 114 | 29.95 | 30.01 | +.03 | 84.0 | +.6 | 90 | 31 | 88 | 72 | 9 | 80 | 12 | 78 | 74 | 75 | 2.02 | −1.7 | 7 | 11.1 | s. | 23 | se. | 3 | 20 | 8 | 3 | 3.5 | .0 | .0 |
| Houston | 138 | 292 | 314 | 29.86 | 30.00 | ..... | 84.0 | +.3 | 97 | 6 | 93 | 70 | 22 | 75 | 27 | ... | ... | ... | 2.94 | −1.0 | 9 | 10.1 | s. | 38 | ne. | 22 | 14 | 11 | 6 | 4.7 | .0 | .0 |
| Palestine | 510 | 64 | 72 | 29.48 | 30.00 | +.03 | 83.4 | +1.2 | 99 | 26 | 94 | 69 | 23 | 73 | 26 | 72 | 68 | 67 | 1.62 | −1.1 | 5 | 7.5 | s. | 25 | s. | 8 | 11 | 15 | 5 | 4.5 | .0 | .0 |
| Port Arthur | 34 | 98 | 106 | 29.98 | 30.02 | ..... | 82.8 | ..... | 94 | 29 | 90 | 65 | 8 | 76 | 23 | 76 | 73 | 75 | 2.57 | −4.4 | 9 | 9.5 | s. | 27 | se. | 8 | 4 | 22 | 5 | 5.1 | .0 | .0 |
| San Antonio | 693 | 242 | 301 | 29.25 | 29.95 | .00 | 83.6 | −.2 | 99 | 27 | 94 | 67 | 8 | 73 | 27 | 72 | 68 | 68 | 1.82 | −.4 | 7 | 10.6 | se. | 38 | se. | 7 | 10 | 13 | 3 | 4.7 | .0 | .0 |

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, July 1937*—Continued

| District and station | Elevation of instruments: Barometer above sea level | Elevation of instruments: Thermometer above ground | Elevation of instruments: Anemometer above ground | Pressure: Station, reduced to mean of 24 hours | Pressure: Sea level, reduced to mean of 24 hours | Pressure: Departure from normal | Temperature of the air: Mean max.+mean min.÷2 | Temperature of the air: Departure from normal | Temperature of the air: Maximum | Temperature of the air: Date | Temperature of the air: Mean maximum | Temperature of the air: Minimum | Temperature of the air: Date | Temperature of the air: Mean minimum | Temperature of the air: Greatest daily range | Mean wet thermometer | Mean temperature of the dew-point | Mean relative humidity | Precipitation: Total | Precipitation: Departure from normal | Precipitation: Days with 0.01 inch or more | Wind: Average hourly velocity | Wind: Prevailing direction | Wind: Maximum velocity: Miles per hour | Wind: Maximum velocity: Direction | Wind: Maximum velocity: Date | Clear days | Partly cloudy days | Cloudy days | Average cloudiness, tenths | Total snowfall | Snow, sleet, and ice, on ground at end of month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ft. | Ft. | Ft. | In. | In. | In. | °F. | °F. | °F. | | °F. | °F. | | °F. | °F. | °F. | °F. | % | In. | In. | | Miles | | | | | | | | 0–10 | In. | In. |
| *Ohio Valley and Tennessee* | | | | | | | 76.0 | −0.4 | | | | | | | | | | 68 | 3.56 | −0.2 | | | | | | | | | | 4.7 | | |
| Chattanooga | 762 | 71 | 214 | 29.21 | 30.00 | −0.02 | 79.8 | +1.4 | 99 | 15 | 90 | 57 | 1 | 69 | 30 | 69 | 64 | 64 | 3.34 | −.9 | 9 | 6.6 | w. | 34 | nw. | 17 | 8 | 19 | 4 | 4.7 | 0.0 | 0.0 |
| Knoxville | 995 | 66 | 84 | 28.98 | 30.01 | −.01 | 78.0 | +.9 | 96 | 15 | 88 | 55 | 2 | 68 | 34 | 69 | 65 | 71 | 6.33 | +2.0 | 12 | 5.0 | w. | 21 | sw. | 19 | 10 | 16 | 5 | 4.3 | .0 | .0 |
| Memphis | 399 | 78 | 86 | 29.58 | 30.00 | .00 | 79.8 | −.9 | 93 | 14 | 87 | 64 | 1 | 72 | 22 | 71 | 67 | 68 | 4.32 | +1.1 | 6 | 6.7 | sw. | 41 | nw. | 16 | 9 | 13 | 9 | 5.3 | .0 | .0 |
| Nashville | 546 | 168 | 188 | 29.45 | 30.03 | +.02 | 78.2 | −.9 | 96 | 15 | 88 | 55 | 2 | 68 | 30 | 68 | 63 | 67 | 2.49 | −1.4 | 9 | 7.0 | w. | 36 | nw. | 17 | 12 | 14 | 5 | 4.2 | .0 | .0 |
| Lexington | 989 | 6 | | | | | 76.2 | +.3 | 95 | 10 | 89 | 47 | 2 | 64 | 36 | | | | 3.17 | −.5 | 9 | | n. | | | | 16 | 13 | 2 | | .0 | |
| Louisville | 525 | 188 | 234 | 29.44 | 30.02 | +.02 | 77.2 | −1.4 | 94 | 16 | 87 | 56 | 1 | 68 | 26 | 67 | 62 | 64 | .93 | −2.8 | 7 | 8.4 | sw. | 29 | w. | 16 | 12 | 13 | 6 | 4.4 | .0 | .0 |
| Evansville | 431 | 76 | 116 | 29.54 | 30.00 | .00 | 78.1 | −.8 | 95 | 15 | 88 | 55 | 1 | 68 | 26 | 68 | 63 | 63 | 1.76 | −1.7 | 9 | 7.2 | sw. | 30 | nw. | 16 | 12 | 12 | 7 | 4.4 | .0 | .0 |
| Indianapolis | 822 | 194 | 230 | 29.13 | 30.00 | +.01 | 75.4 | −.3 | 93 | 7 | 85 | 51 | 1 | 66 | 25 | 65 | 60 | 63 | 5.37 | +2.0 | 9 | 8.4 | sw. | 44 | w. | 25 | 18 | 11 | 2 | 3.5 | .0 | .0 |
| Terre Haute | 575 | 63 | 149 | 29.37 | 29.97 | | 77.4 | | 97 | 9 | 89 | 53 | 1 | 66 | 28 | 67 | 62 | 64 | 2.78 | −.4 | 6 | 7.2 | sw. | 36 | w. | 25 | 18 | 11 | 2 | 3.5 | .0 | .0 |
| Cincinnati | 627 | 11 | 51 | 29.34 | 30.00 | .00 | 75.3 | +.2 | 94 | 9 | 86 | 50 | 1 | 64 | 30 | 66 | 62 | 71 | 3.94 | +.6 | 6 | 5.8 | sw. | 24 | sw. | 25 | 14 | 10 | 7 | 4.5 | .0 | .0 |
| Columbus | 822 | 90 | 210 | 29.13 | 29.99 | −.01 | 75.1 | +.2 | 94 | 10 | 85 | 54 | 2 | 65 | 26 | 66 | 62 | 66 | 3.91 | +.4 | 11 | 7.7 | s. | 31 | w. | 25 | 14 | 11 | 6 | 4.1 | .0 | .0 |
| Dayton | 900 | 60 | 163 | 29.05 | 29.98 | | 74.8 | −.6 | 92 | 9 | 85 | 52 | 1 | 65 | 29 | | | | 3.39 | +.1 | 9 | 6.8 | sw. | 31 | w. | 25 | 14 | 11 | 6 | 4.1 | .0 | .0 |
| Elkins | 1,947 | 59 | 78 | 28.04 | 30.03 | +.02 | 69.0 | −1.3 | 88 | 9 | 80 | 45 | 2 | 58 | 34 | 62 | 60 | 79 | 2.77 | −2.6 | 15 | 4.8 | w. | 21 | nw. | 10 | 5 | 14 | 12 | 6.5 | .0 | .0 |
| Parkersburg | 637 | 77 | 84 | 29.33 | 29.98 | −.03 | 74.5 | −.9 | 94 | 10 | 85 | 52 | 2 | 64 | 32 | 67 | 64 | 74 | 3.26 | −1.0 | 12 | 5.1 | se. | 24 | sw. | 14 | 10 | 16 | 5 | 4.8 | .0 | .0 |
| Pittsburgh [1] | 1,273 | 39 | 54 | 28.67 | 30.00 | .00 | 72.9 | −1.7 | 94 | 8 | 84 | 50 | 1 | 62 | 28 | 64 | 61 | 72 | 5.63 | +1.6 | 14 | 8.7 | sw. | 42 | nw. | 25 | 7 | 12 | 12 | 6.1 | .0 | .0 |
| | | | | | | | 72.7 | +1.2 | | | | | | | | | | 68 | 3.06 | −0.2 | | | | | | | | | | 4.9 | | |
| *Lower Lake Region* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Buffalo | 768 | 243 | 280 | 29.14 | 29.95 | −.02 | 71.0 | +1.2 | 87 | 5 | 77 | 52 | 27 | 65 | 26 | 65 | 61 | 73 | 3.00 | .0 | 8 | 13.0 | sw. | 50 | sw. | 26 | 10 | 11 | 10 | 5.3 | .0 | .0 |
| Canton | 448 | 10 | 61 | 29.46 | 29.92 | | 71.1 | +.6 | 90 | 23 | 82 | 52 | 19 | 60 | 31 | 65 | 61 | 73 | .96 | −2.5 | 8 | 7.1 | sw. | 24 | sw. | 27 | 10 | 12 | 9 | 5.4 | .0 | .0 |
| Ithaca | 836 | 77 | 100 | 29.08 | 29.96 | | 71.8 | +1.3 | 96 | 8 | 84 | 49 | 2 | 60 | 34 | 64 | 60 | 67 | 1.61 | −1.9 | 11 | 6.9 | nw. | 22 | s. | 2 | 10 | 11 | 10 | 5.5 | .0 | .0 |
| Oswego | 335 | 71 | 85 | 29.58 | 29.94 | −.02 | 71.2 | +.8 | 90 | 23 | 79 | 52 | 2 | 63 | 24 | 65 | 61 | 70 | 1.33 | −1.6 | 8 | 7.1 | s. | 22 | n. | 17 | 14 | 8 | 9 | 5.0 | .0 | .0 |
| Rochester | 523 | 86 | 102 | 29.41 | 29.97 | .00 | 72.8 | +2.1 | 93 | 10 | 82 | 54 | 2 | 64 | 27 | 64 | 59 | 64 | 1.92 | −1.0 | 9 | 7.7 | sw. | 30 | w. | 17 | 14 | 8 | 9 | 4.7 | .0 | .0 |
| Syracuse | 596 | 65 | 79 | 29.33 | 29.97 | .00 | 73.4 | +2.8 | 93 | 8 | 83 | 55 | 2 | 64 | 27 | | | | 2.85 | −.8 | 15 | 6.6 | s. | 23 | nw. | 17 | 11 | 12 | 8 | 5.0 | .0 | .0 |
| Erie | 714 | 130 | 166 | 29.22 | 29.97 | −.01 | 73.1 | +2.1 | 91 | 8 | 80 | 56 | 2 | 66 | 24 | 65 | 61 | 68 | 1.60 | −1.4 | 11 | 10.5 | nw. | 35 | sw. | 25 | 10 | 17 | 4 | 4.6 | .0 | .0 |
| Cleveland | 762 | 267 | 318 | 29.17 | 29.98 | −.01 | 73.2 | +1.8 | 89 | 8 | 80 | 54 | 1 | 66 | 22 | 65 | 61 | 67 | 4.87 | +1.4 | 11 | 11.6 | s. | 56 | w. | 15 | 11 | 14 | 6 | 4.6 | .0 | .0 |
| Sandusky | 629 | 5 | 67 | 29.30 | 29.98 | −.01 | 74.1 | +.7 | 95 | 9 | 83 | 51 | 27 | 65 | 30 | | | | 3.54 | +.1 | 12 | 7.4 | sw. | 30 | nw. | 16 | 8 | 17 | 6 | 5.1 | .0 | .0 |
| Toledo | 628 | 79 | 87 | 29.32 | 29.99 | .00 | 74.0 | +.8 | 95 | 8 | 83 | 51 | 1 | 65 | 25 | 65 | 61 | 67 | 4.55 | +1.5 | 11 | 8.1 | w. | 29 | w. | 14 | 14 | 14 | 3 | 4.2 | .0 | .0 |
| Fort Wayne | 857 | 69 | 84 | 29.08 | 29.99 | | 74.0 | +.8 | 95 | 8 | 83 | 51 | 1 | 65 | 25 | 65 | 61 | 67 | 4.55 | +1.5 | 11 | 8.1 | w. | 29 | w. | 14 | 14 | 14 | 3 | 4.2 | .0 | .0 |
| Detroit | 626 | 5 | 78 | 29.30 | 29.97 | −.01 | 73.8 | −.7 | 93 | 11 | 84 | 48 | 1 | 64 | 27 | 65 | 60 | 67 | 3.51 | −.1 | 9 | 7.2 | sw. | 38 | w. | 15 | 8 | 18 | 5 | 5.0 | .0 | .0 |
| | | | | | | | 72.8 | +.7 | 95 | 8 | 82 | 50 | 3 | 63 | 28 | 65 | 61 | 68 | 7.03 | +3.7 | 13 | 8.4 | sw. | 31 | nw. | 9 | 13 | 10 | 8 | 4.8 | .0 | .0 |
| | | | | | | | 70.2 | +2.3 | | | | | | | | | | 70 | 2.74 | −0.4 | | | | | | | | | | 4.4 | | |
| *Upper Lake Region* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alpena | 609 | 13 | 89 | 29.29 | 29.95 | −.02 | 69.0 | +3.1 | 97 | 7 | 78 | 48 | 3 | 60 | 32 | 62 | 59 | 75 | 3.75 | +1.0 | 10 | 9.0 | nw. | 30 | nw. | 10 | 11 | 16 | 4 | 4.5 | .0 | .0 |
| Escanaba | 612 | 41 | 49 | 29.30 | 29.95 | −.02 | 67.9 | +1.9 | 89 | 23 | 77 | 45 | 31 | 59 | 31 | 61 | 57 | 71 | 2.98 | −.4 | 12 | 7.6 | s. | 23 | nw. | 25 | 8 | 19 | 4 | 4.5 | .0 | .0 |
| Grand Rapids | 707 | 70 | 244 | 29.21 | 29.96 | −.02 | 74.3 | +2.0 | 95 | 11 | 85 | 49 | 1 | 64 | 28 | 65 | 60 | 64 | 1.33 | −1.6 | 9 | 9.0 | sw. | 33 | sw. | 15 | 15 | 8 | 8 | 4.0 | .0 | .0 |
| Lansing | 878 | 5 | 90 | 29.04 | 29.96 | | 70.6 | −.3 | 91 | 10 | 81 | 44 | 1 | 60 | 31 | 65 | 62 | 76 | 1.64 | −1.5 | 9 | 6.9 | s. | 21 | w. | 26 | 15 | 9 | 7 | 4.1 | .0 | .0 |
| Ludington | 637 | 5 | 54 | 29.26 | 29.95 | | 69.6 | +3.4 | 89 | 9 | 78 | 48 | 1 | 61 | 25 | 64 | 60 | | 1.83 | −1.2 | 9 | | s. | | | | 19 | 11 | 1 | | .0 | |
| Marquette | 734 | 44 | 69 | 29.15 | 29.94 | −.02 | 67.2 | +2.3 | 96 | 7 | 76 | 47 | 31 | 58 | 30 | 60 | 56 | 71 | 5.03 | +1.9 | 12 | 7.1 | nw. | 26 | sw. | 23 | 10 | 12 | 9 | 5.5 | .0 | .0 |
| Sault Sainte Marie | 614 | 11 | 52 | 29.28 | 29.96 | −.01 | 66.6 | +2.8 | 93 | 7 | 77 | 44 | 1 | 56 | 36 | 59 | 55 | 71 | 4.22 | +1.3 | 10 | 6.5 | nw. | 21 | nw. | 9 | 11 | 14 | 6 | 4.7 | .0 | .0 |
| Chicago | 673 | 7 | 131 | 29.26 | 29.97 | −.01 | 74.4 | +1.9 | 92 | 11 | 82 | 54 | 1 | 66 | 22 | 66 | 62 | 70 | 1.41 | −1.9 | 10 | 8.3 | sw. | 28 | sw. | 12 | 17 | 11 | 3 | 3.6 | .0 | .0 |
| Green Bay | 617 | 109 | 141 | 29.28 | 29.94 | −.03 | 73.0 | +3.0 | 97 | 11 | 83 | 49 | 27 | 63 | 30 | 63 | 57 | 62 | 2.15 | −1.3 | 7 | 9.7 | s. | 31 | nw. | 25 | 11 | 15 | 5 | 4.6 | .0 | .0 |
| Milwaukee | 681 | 97 | 221 | 29.23 | 29.96 | −.01 | 73.5 | +3.4 | 97 | 11 | 82 | 56 | 1 | 65 | 28 | 64 | 59 | 64 | 3.06 | +.2 | 8 | 10.5 | w. | 34 | n. | 10 | 14 | 12 | 5 | 4.1 | .0 | .0 |
| Duluth | 1,133 | 5 | 47 | 28.73 | 29.93 | −.02 | 66.0 | +2.1 | 90 | 2 | 76 | 48 | 17 | 56 | 39 | 59 | 56 | 77 | 2.73 | −1.0 | 7 | 10.1 | ne. | 27 | ne. | 16 | 11 | 13 | 7 | 4.9 | .0 | .0 |
| | | | | | | | 72.0 | +3.7 | | | | | | | | | | 64 | 2.90 | +0.3 | | | | | | | | | | 4.7 | | |
| *North Dakota* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Moorhead, Minn | 940 | 50 | 58 | 28.92 | 29.91 | −.03 | 72.1 | +4.0 | 101 | 6 | 84 | 50 | 17 | 61 | 31 | 64 | 59 | 68 | 2.68 | −.8 | 9 | 8.1 | s. | 27 | nw. | 24 | 10 | 12 | 9 | 5.5 | .0 | .0 |
| Bismarck | 1,674 | 8 | 57 | 28.16 | 29.90 | −.03 | 73.6 | +3.8 | 100 | 5 | 85 | 50 | 28 | 62 | 36 | 63 | 57 | 62 | 2.17 | −.1 | 9 | 8.3 | nw. | 30 | nw. | 24 | 11 | 14 | 6 | 4.7 | .0 | .0 |
| Devils Lake | 1,478 | 11 | 44 | 28.39 | 29.93 | .00 | 70.6 | +3.2 | 96 | 9 | 82 | 49 | 28 | 59 | 37 | 62 | 57 | 70 | 3.26 | +.7 | 14 | 8.0 | n. | 27 | n. | 22 | 12 | 10 | 9 | 5.5 | .0 | .0 |
| Grand Forks | 833 | 12 | 67 | | | | 69.6 | +2.1 | 95 | 6 | 81 | 48 | 25 | 58 | 36 | 64 | | | 4.66 | +1.9 | 10 | | se. | 29 | nw. | 16 | 8 | 14 | 9 | | .0 | .0 |
| Williston | 1,878 | 42 | 50 | 27.97 | 29.89 | −.03 | 74.1 | +5.2 | 108 | 5 | 86 | 50 | 28 | 62 | 36 | 61 | 52 | 54 | 1.75 | −.1 | 10 | 7.6 | se. | 29 | se. | 11 | 16 | 11 | 4 | 3.7 | .0 | .0 |
| | | | | | | | 77.0 | +1.9 | | | | | | | | | | 63 | 2.33 | −1.2 | | | | | | | | | | 4.1 | | |
| *Upper Mississippi Valley* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mpls.-St. P., Minn | 919 | 105 | 208 | 28.96 | 29.92 | −.03 | 77.0 | +4.7 | 100 | 10 | 88 | 52 | 17 | 67 | 26 | 65 | 58 | 55 | .48 | −3.2 | 5 | 9.7 | s. | 35 | w. | 16 | 16 | 7 | 8 | 4.0 | .0 | .0 |
| La Crosse | 714 | 11 | 48 | 29.18 | 29.92 | −.04 | 75.7 | +2.9 | 96 | 10 | 87 | 52 | 27 | 64 | 32 | 66 | 62 | 67 | 1.63 | −2.3 | 5 | 4.9 | s. | 18 | nw. | 25 | 17 | 12 | 2 | 3.4 | .0 | .0 |
| Madison | 974 | 70 | 78 | 28.93 | 29.94 | −.03 | 75.0 | +2.9 | 94 | 8 | 84 | 55 | 26 | 66 | 24 | 64 | 59 | 61 | 1.49 | −2.4 | 5 | 6.1 | sw. | 22 | nw. | 25 | 17 | 8 | 8 | 4.1 | .0 | .0 |
| Charles City | 1,015 | 10 | 51 | 28.90 | 29.96 | .00 | 74.8 | +2.5 | 97 | 10 | 86 | 50 | 26 | 63 | 32 | 65 | 60 | 64 | .70 | −3.1 | 4 | 5.7 | se. | 19 | nw. | 16 | 19 | 10 | 2 | 2.8 | .0 | .0 |
| Davenport | 606 | 66 | 161 | 29.32 | 29.97 | .00 | 77.8 | +2.5 | 97 | 10 | 88 | 57 | 27 | 68 | 28 | 67 | 61 | 61 | 4.99 | +1.7 | 9 | 7.5 | sw. | 37 | w. | 13 | 14 | 11 | 6 | 4.3 | .0 | .0 |
| Des Moines | 861 | 5 | 99 | 29.06 | 29.94 | −.02 | 77.6 | +2.2 | 96 | 10 | 89 | 57 | 26 | 66 | 31 | 68 | 63 | 64 | .58 | −2.9 | 6 | 7.4 | s. | 25 | nw. | 25 | 11 | 13 | 7 | 4.0 | .0 | .0 |
| Dubuque | 699 | 60 | 79 | 29.22 | 29.95 | −.02 | 75.9 | +1.8 | 97 | 10 | 87 | 53 | 27 | 65 | 31 | 66 | 61 | 63 | 1.57 | −2.4 | 7 | 5.1 | s. | 19 | nw. | 25 | 16 | 9 | 6 | 3.8 | .0 | .0 |
| Keokuk | 614 | 64 | 78 | 29.32 | 29.96 | −.02 | 77.9 | +1.0 | 96 | 10 | 88 | 58 | 1 | 68 | 27 | 68 | 62 | 63 | 5.34 | +1.9 | 13 | 5.5 | sw. | 31 | ne. | 8 | 8 | 16 | 7 | 5.2 | .0 | .0 |
| Cairo | 358 | 87 | 93 | 29.61 | 29.98 | −.02 | 79.2 | −.4 | 95 | 15 | 87 | 61 | 1 | 71 | 24 | 70 | 67 | 71 | 1.53 | −1.5 | 6 | 7.1 | s. | 24 | n. | 16 | 9 | 12 | 10 | 5.5 | .0 | .0 |
| Peoria | 609 | 11 | 45 | 29.33 | 29.99 | +.01 | 75.8 | +.4 | 95 | 10 | 87 | 51 | 27 | 65 | 31 | 67 | 63 | 67 | 2.32 | −1.3 | 6 | 4.8 | sw. | 18 | nw. | 25 | 19 | 9 | 3 | 3.1 | .0 | .0 |
| Springfield, Ill | 636 | 5 | 191 | 29.31 | 29.97 | −.01 | 78.0 | +1.5 | 96 | 10 | 88 | 57 | 1 | 68 | 25 | 67 | 62 | 63 | 6.70 | +3.8 | 6 | 8.9 | s. | 28 | nw. | 13 | 11 | 17 | 3 | 4.4 | .0 | .0 |
| St. Louis | 568 | 179 | 303 | 29.38 | 29.97 | −.02 | 79.8 | +1.0 | 96 | 16 | 89 | 62 | 1 | 71 | 23 | 68 | 63 | 62 | .67 | −2.3 | 9 | 9.8 | sw. | 29 | sw. | 16 | 13 | 16 | 2 | 3.8 | .0 | .0 |
| | | | | | | | 79.4 | +3.6 | | | | | | | | | | 60 | 3.13 | −0.6 | | | | | | | | | | 3.7 | | |
| *Missouri Valley* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Columbia, Mo | 784 | 6 | 66 | 29.14 | 29.95 | −.03 | 79.0 | +2.1 | 96 | 10 | 90 | 56 | 27 | 68 | 28 | | | | 2.92 | −.6 | 9 | 6.4 | e. | 27 | ne. | 18 | 11 | 18 | 2 | 4.3 | .0 | .0 |
| Kansas City [1] | 750 | 32 | 45 | 29.15 | 29.93 | −.04 | 81.4 | +3.3 | 103 | 4 | 92 | 61 | 26 | 70 | 34 | 70 | 65 | 62 | 3.11 | −1.0 | 10 | 8.0 | sw. | 45 | nw. | 15 | 19 | 10 | 2 | 2.8 | .0 | .0 |
| St. Joseph | 967 | 11 | 49 | 28.93 | 29.93 | | 80.5 | | 100 | 4 | 92 | 60 | 26 | 69 | 31 | 69 | 64 | 63 | 7.89 | +4.1 | 9 | 7.2 | se. | 30 | nw. | 15 | 19 | 13 | 3 | 4.0 | .0 | .0 |
| Springfield, Mo | 1,324 | 98 | 104 | 28.60 | 29.97 | −.01 | 77.8 | +1.0 | 95 | 4 | 87 | 60 | 26 | 69 | 26 | 69 | 65 | 69 | 3.95 | −.3 | 11 | 8.5 | s. | 27 | n. | 19 | 13 | 15 | 3 | 4.0 | .0 | .0 |
| Topeka | 987 | 65 | 87 | 28.89 | 29.91 | | 82.6 | +4.8 | 105 | 4 | 96 | 61 | 26 | 70 | 36 | 70 | 64 | 60 | 1.65 | −2.6 | 9 | 8.5 | s. | 33 | n. | 18 | 11 | 18 | 2 | 4.0 | .0 | .0 |
| Lincoln | 1,189 | 11 | 81 | 28.68 | 29.90 | −.05 | 80.8 | +4.3 | 105 | 6 | 93 | 57 | 2 | 69 | 38 | 67 | 61 | 56 | 3.10 | −.8 | 6 | 8.6 | s. | 38 | s. | 29 | 20 | 14 | 12 | 3.7 | .0 | .0 |
| Omaha [1] | 982 | 31 | 44 | 28.90 | 29.92 | −.03 | 79.6 | +2.9 | 100 | 7 | 91 | 60 | 26 | 68 | 33 | 68 | 62 | 61 | 5.04 | +1.5 | 6 | 8.5 | se. | 39 | nw. | 20 | 20 | 7 | 4 | 3.6 | .0 | .0 |
| Valentine | 2,598 | 47 | 54 | 27.29 | 29.94 | +.01 | 77.9 | +4.2 | 104 | 5 | 92 | 58 | 16 | 64 | 37 | 63 | 55 | 54 | 1.08 | −1.9 | 8 | 9.1 | s. | 27 | se. | 10 | 13 | 17 | 1 | 3.3 | .0 | .0 |
| Sioux City | 1,138 | 64 | 106 | 28.73 | 29.91 | −.04 | 78.6 | +4.3 | 103 | 7 | 90 | 55 | 17 | 67 | 32 | 66 | 60 | 58 | 1.61 | −1.9 | 8 | 7.8 | s. | 29 | s. | 10 | 13 | 15 | 3 | 4.2 | .0 | .0 |
| Huron | 1,307 | 59 | 74 | 28.54 | 29.90 | −.04 | 77.3 | +5.5 | 109 | 6 | 91 | 52 | 17 | 64 | 36 | 64 | 57 | 57 | .98 | −2.2 | 5 | 8.7 | se. | 26 | sw. | 10 | 20 | 10 | 1 | 2.9 | .0 | .0 |
| | | | | | | | 71.6 | +3.9 | | | | | | | | | | 55 | 1.93 | +0.4 | | | | | | | | | | 4.3 | | |
| *Northern Slope* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Havre | 2,507 | 11 | 67 | 27.34 | 29.92 | +.01 | 72.6 | +4.3 | 105 | 4 | 87 | 52 | 7 | 59 | 41 | 58 | 48 | 52 | 2.19 | +.3 | 8 | 7.9 | e. | 43 | sw. | 13 | 13 | 13 | 5 | 4.2 | .0 | .0 |
| Helena | 4,124 | 85 | 111 | 25.85 | 29.95 | +.02 | 70.8 | +5.1 | 97 | 4 | 84 | 50 | 15 | 57 | 34 | 55 | 44 | 45 | 1.38 | +.2 | 13 | 8.4 | sw. | 32 | s. | 20 | 9 | 15 | 7 | 4.7 | .0 | .0 |
| Missoula | 2,263 | 80 | 91 | | | | 72.6 | +5.0 | 101 | 4 | 88 | 48 | 31 | 57 | 40 | | | | .47 | −.5 | 6 | 7.3 | nw. | 29 | e. | 11 | 13 | 13 | 5 | 3.6 | .0 | .0 |
| Kalispell | 2,973 | 48 | 56 | 26.95 | 29.94 | +.01 | 68.0 | +3.9 | 93 | 4 | 82 | 49 | 31 | 54 | 39 | 55 | 45 | 52 | .83 | −.3 | 6 | 6.2 | w. | 23 | nw. | 11 | 14 | 11 | 6 | 3.9 | .0 | .0 |
| Miles City | 2,371 | 48 | 55 | 27.44 | 29.92 | .00 | 76.7 | +3.8 | 107 | 5 | 89 | 54 | 15 | 64 | 39 | 62 | 52 | 50 | 1.76 | +.2 | 11 | 6.0 | s. | 35 | nw. | 5 | 12 | 11 | 8 | 4.6 | .0 | .0 |
| Rapid City | 3,259 | 50 | 58 | 26.65 | 29.97 | +.04 | 74.6 | +3.6 | 102 | 5 | 90 | 54 | 17 | 63 | 39 | 62 | 54 | 55 | 3.45 | +1.1 | 11 | 7.2 | n. | 27 | n. | 16 | 18 | 11 | 2 | 3.5 | .0 | .0 |
| Cheyenne [1] | 6,144 | 5 | 39 | 24.07 | 29.95 | +.03 | 69.4 | +2.7 | 93 | 22 | 85 | 49 | 18 | 54 | 40 | 55 | 49 | 59 | 1.97 | −.1 | 11 | 9.8 | w. | 41 | nw. | 18 | 11 | 17 | 3 | 4.5 | .0 | .0 |
| Lander | 5,372 | 60 | 68 | 24.74 | 29.96 | +.04 | 69.4 | +2.0 | 96 | 4 | 84 | 46 | 15 | 55 | 39 | 58 | 48 | 57 | 2.79 | +2.1 | 12 | 5.0 | sw. | 41 | w. | 28 | 15 | 14 | 8 | 5.4 | .0 | .0 |
| Sheridan | 3,790 | 10 | 47 | 26.13 | 29.95 | | 70.4 | | 103 | 5 | 85 | 47 | 16 | 56 | 47 | 60 | 54 | 64 | 1.78 | +.6 | 12 | 4.4 | nw. | 23 | nw. | 28 | 15 | 7 | 9 | 4.4 | .0 | .0 |
| Yellowstone Park | 6,241 | 12 | 46 | 24.01 | 30.06 | +.14 | 63.1 | +2.2 | 86 | 21 | 77 | 38 | 15 | 49 | 36 | 51 | 44 | 61 | 2.42 | +1.2 | 13 | 7.1 | sw. | 27 | sw. | 21 | 18 | 13 | 0 | 3.2 | .0 | .0 |
| North Platte | 2,821 | 11 | 51 | 27.06 | 29.90 | −.03 | 79.0 | +6.1 | 104 | 5 | 93 | 60 | 20 | 65 | 36 | 64 | 58 | 56 | 2.21 | −.5 | 11 | 7.2 | se. | 25 | nw. | 23 | 18 | 13 | 0 | | | |

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, July 1937*—Continued

| District and station | Elevation of instruments: Barometer above sea level | Elevation of instruments: Thermometer above ground | Elevation of instruments: Anemometer above ground | Pressure: Station, reduced to mean of 24 hours | Pressure: Sea level, reduced to mean of 24 hours | Pressure: Departure from normal | Temperature of the air: Mean max.+mean min.÷2 | Temperature of the air: Departure from normal | Temperature of the air: Maximum | Temperature of the air: Date | Temperature of the air: Mean maximum | Temperature of the air: Minimum | Temperature of the air: Date | Temperature of the air: Mean minimum | Temperature of the air: Greatest daily range | Mean wet thermometer | Mean temperature of the dew-point | Mean relative humidity | Precipitation: Total | Precipitation: Departure from normal | Precipitation: Days with 0.01 inch or more | Wind: Average hourly velocity | Wind: Prevailing direction | Wind: Maximum velocity: Miles per hour | Wind: Maximum velocity: Direction | Wind: Maximum velocity: Date | Clear days | Partly cloudy days | Cloudy days | Average cloudiness, tenths | Total snowfall | Snow, sleet, and ice, on ground at end of month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Ft.* | *Ft.* | *Ft.* | *In.* | *In.* | *In.* | °F. | °F. | °F. | | °F. | °F. | | °F. | °F. | °F. | °F. | % | *In.* | *In.* | | *Miles* | | | | | | | *0–10* | *In.* | *In.* |
| ***Middle Slope*** | | | | | | | **80.4** | **+3.3** | | | | | | | | | | **52** | **2.20** | **−0.6** | | | | | | | | | **3.9** | | |
| Denver | 5,292 | 106 | 113 | 24.82 | 29.95 | +0.04 | 74.8 | +2.6 | 96 | 22 | 87 | 57 | 14 | 62 | 32 | 57 | 48 | 46 | .95 | −.7 | 7 | 7.6 | s. | 32 | n. | 22 | 13 | 14 | 4 | 4.3 | 0.0 | 0.0 |
| Pueblo | 4,685 | 80 | 86 | 25.35 | 29.90 | −.01 | 77.6 | +3.4 | 100 | 22 | 92 | 55 | 19 | 63 | 39 | 58 | 47 | 42 | .68 | −1.3 | 6 | 7.3 | e. | 34 | nw. | 24 | 17 | 11 | 3 | 3.8 | .0 | .0 |
| Concordia | 1,392 | 50 | 58 | 28.47 | 29.90 | −.05 | 81.8 | +3.8 | 108 | 5 | 94 | 59 | 26 | 70 | 34 | 68 | 61 | 56 | 4.06 | +.3 | 10 | 7.6 | s. | 28 | ne. | 25 | 17 | 12 | 2 | 3.6 | .0 | .0 |
| Dodge City | 2,509 | 10 | 86 | 27.36 | 29.88 | −.05 | 82.0 | +3.6 | 103 | 4 | 96 | 60 | 26 | 68 | 37 | 66 | 58 | 52 | 1.99 | −1.2 | 8 | 11.6 | se. | 36 | n. | 19 | 16 | 13 | 2 | 3.2 | .0 | .0 |
| Wichita | 1,358 | 85 | 93 | 28.52 | 29.91 | −.05 | 81.8 | +2.4 | 106 | 5 | 93 | 63 | 26 | 71 | 33 | 69 | 63 | 59 | 4.77 | +1.4 | 10 | 11.0 | se. | 37 | ne. | 5 | 16 | 12 | 3 | 3.7 | .0 | .0 |
| Oklahoma City | 1,214 | 10 | 47 | 28.67 | 29.91 | −.05 | 84.4 | +3.8 | 102 | 7 | 95 | 64 | 26 | 73 | 28 | 70 | 64 | 57 | .74 | −2.1 | 7 | 10.1 | s. | 23 | s. | 14 | 11 | 15 | 5 | 4.6 | .0 | .0 |
| ***Southern Slope*** | | | | | | | **82.9** | **+1.7** | | | | | | | | | | **50** | **0.88** | **−1.5** | | | | | | | | | **3.4** | | |
| Abilene | 1,738 | 10 | 52 | 28.16 | 29.91 | −.02 | 85.5 | +2.7 | 102 | 30 | 97 | 66 | 27 | 74 | 35 | 68 | 60 | 50 | .22 | −1.9 | 4 | 10.3 | s. | 28 | nw. | 20 | 12 | 13 | 6 | 4.5 | .0 | .0 |
| Amarillo | 3,676 | 10 | 49 | 26.29 | 29.90 | −.02 | 81.0 | +4.2 | 101 | 31 | 94 | 60 | 9 | 68 | 32 | 63 | 54 | 47 | 1.49 | −1.4 | 5 | 9.0 | s. | 27 | ne. | 25 | 17 | 12 | 2 | 3.6 | .0 | .0 |
| Del Rio | 960 | 63 | 71 | 28.92 | 29.86 | −.04 | 85.1 | −1.2 | 103 | 1 | 95 | 66 | 8 | 75 | 25 | 71 | 64 | 57 | .88 | −1.5 | 5 | 10.7 | se. | 34 | se. | 4 | 14 | 13 | 4 | 4.2 | .0 | .0 |
| Roswell | 3,566 | 75 | 85 | 26.38 | 29.89 | +.01 | 80.0 | +1.1 | 102 | 16 | 94 | 59 | 9 | 66 | 35 | 63 | 52 | 46 | .94 | −1.3 | 4 | 7.7 | s. | 35 | ne. | 20 | 26 | 5 | 0 | 1.5 | .0 | .0 |
| ***Southern Plateau*** | | | | | | | **80.1** | **+1.5** | | | | | | | | | | **45** | **0.82** | **−0.7** | | | | | | | | | **3.0** | | |
| El Paso | 3,778 | 82 | 101 | 26.16 | 29.82 | −.02 | 84.4 | +3.3 | 102 | 16 | 97 | 63 | 8 | 72 | 31 | 63 | 50 | 36 | .39 | −1.6 | 4 | 8.0 | e. | 27 | ne. | 8 | 19 | 12 | 0 | 2.5 | .0 | .0 |
| Albuquerque [1] | 4,972 | 5 | 39 | 25.10 | 29.87 | ..... | 76.8 | +.1 | 99 | 24 | 92 | 55 | 12 | 62 | 38 | 60 | 51 | 50 | 1.02 | −.4 | 9 | 7.2 | n. | 33 | w. | 31 | 15 | 13 | 3 | 3.7 | .0 | .0 |
| Santa Fe | 7,013 | 38 | 53 | 23.38 | 29.93 | +.05 | 69.8 | +.8 | 90 | 22 | 82 | 50 | 12 | 58 | 33 | 55 | 46 | 51 | .71 | −1.7 | 7 | 5.6 | e. | 24 | ne. | 22 | 13 | 11 | 7 | 4.6 | .0 | .0 |
| Flagstaff | 6,907 | 10 | 59 | 23.47 | 29.88 | +.05 | 66.4 | +1.4 | 92 | 21 | 81 | 46 | 12 | 52 | 43 | 53 | ..... | 57 | 2.69 | −.5 | 15 | 7.1 | nw. | 22 | nw. | 11 | 5 | 13 | 13 | ..... | .0 | .0 |
| Phoenix | 1,107 | 39 | 51 | 28.66 | 29.77 | −.01 | 91.8 | +2.0 | 114 | 2 | 105 | 68 | 11 | 78 | 38 | 70 | 57 | 37 | .49 | −.6 | 5 | 6.8 | w. | 32 | ne. | 7 | 21 | 8 | 2 | 2.6 | .0 | .0 |
| Yuma | 141 | 9 | 54 | 29.62 | 29.76 | .00 | 92.8 | +2.0 | 117 | 2 | 107 | 72 | 17 | 78 | 40 | 73 | 63 | 41 | .46 | +.3 | 5 | 5.6 | sw. | 24 | e. | 7 | 26 | 5 | 0 | 1.7 | .0 | .0 |
| Independence | 3,957 | 5 | 26 | 25.96 | 29.90 | +.07 | 78.7 | +.6 | 103 | 3 | 96 | 52 | 31 | 62 | 45 | 56 | 37 | ..... | T | −.1 | 0 | ..... | s. | ..... | ..... | ..... | 21 | 5 | 5 | ..... | .0 | .0 |
| ***Middle Plateau*** | | | | | | | **74.8** | **+2.6** | | | | | | | | | | **41** | **1.02** | **+0.5** | | | | | | | | | **3.6** | | |
| Reno | 4,527 | 61 | 76 | 25.49 | 29.92 | +.05 | 73.2 | +3.1 | 98 | 3 | 90 | 49 | 14 | 56 | 45 | 54 | 41 | 39 | .36 | +.1 | 4 | 6.7 | sw. | 29 | se. | 9 | 23 | 6 | 2 | 1.9 | .0 | .0 |
| Tonopah | 6,090 | 12 | 20 | ..... | ..... | ..... | 75.9 | ..... | 94 | 3 | 88 | 56 | 13 | 64 | 29 | 54 | 38 | 31 | .05 | ..... | 3 | ..... | se. | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Winnemucca | 4,344 | 18 | 56 | 25.61 | 29.90 | −.00 | 75.4 | +4.8 | 102 | 3 | 94 | 46 | 19 | 56 | 51 | 54 | 38 | 34 | .30 | +.1 | 5 | 7.6 | sw. | 32 | se. | 22 | 18 | 12 | 1 | 3.2 | .0 | .0 |
| Modena | 5,473 | 10 | 43 | 24.67 | 29.89 | +.03 | 72.2 | +1.6 | 97 | 2 | 88 | 50 | 13 | 57 | 45 | 56 | 46 | 50 | 2.49 | +1.4 | 13 | 9.3 | sw. | 35 | nw. | 8 | 13 | 9 | 9 | 4.5 | .0 | .0 |
| Salt Lake City [1] | 4,227 | 32 | 46 | 25.73 | 29.87 | −.03 | 77.6 | ..... | 104 | 21 | 92 | 57 | 15 | 63 | 43 | 60 | 49 | 45 | 1.21 | ..... | 11 | 9.1 | se. | 45 | nw. | 28 | 11 | 14 | 6 | 4.5 | .0 | .0 |
| Grand Junction | 4,602 | 60 | 68 | 25.42 | 29.92 | +.03 | 78.6 | +.9 | 100 | 3 | 91 | 60 | 10 | 66 | 32 | 60 | 50 | 45 | .94 | +.3 | 7 | 6.9 | se. | 27 | sw. | 7 | 16 | 9 | 6 | 3.9 | .0 | .0 |
| ***Northern Plateau*** | | | | | | | **74.4** | **+3.8** | | | | | | | | | | **41** | **0.36** | **−0.1** | | | | | | | | | **2.6** | | |
| Baker | 3,471 | 36 | 54 | 26.47 | 29.98 | +.03 | 69.4 | +3.8 | 99 | 4 | 86 | 40 | 31 | 53 | 44 | 54 | 43 | 46 | .27 | −.3 | 3 | 6.3 | n. | 26 | sw. | 17 | 22 | 7 | 2 | 2.2 | .0 | .0 |
| Boise | 2,739 | 79 | 87 | 27.12 | 29.91 | −.02 | 76.9 | +4.0 | 106 | 4 | 92 | 55 | 15 | 62 | 42 | 58 | 45 | 38 | .07 | −.2 | 2 | 5.7 | nw. | 27 | nw. | 31 | 19 | 11 | 1 | 2.9 | .0 | .0 |
| Pocatello | 4,477 | 60 | 68 | 25.50 | 29.89 | −.03 | 74.4 | +3.6 | 98 | 4 | 89 | 48 | 15 | 60 | 40 | 56 | 44 | 41 | 1.10 | +.3 | 7 | 8.5 | se. | 32 | s. | 30 | 12 | 12 | 7 | 4.5 | .0 | .0 |
| Spokane | 1,929 | 101 | 110 | 27.94 | 29.94 | −.02 | 72.4 | +3.4 | 98 | 24 | 86 | 52 | 7 | 59 | 38 | 57 | 46 | 46 | .56 | −.1 | 5 | 6.2 | s. | 27 | s. | 27 | 22 | 5 | 4 | 2.7 | .0 | .0 |
| Walla Walla | 991 | 57 | 65 | 28.89 | 29.94 | −.03 | 77.6 | +3.6 | 103 | 27 | 90 | 56 | 31 | 65 | 36 | 59 | 45 | 37 | .15 | −.2 | 2 | 6.1 | w. | 20 | w. | 27 | 26 | 4 | 1 | 1.7 | .0 | .0 |
| Yakima | 1,076 | 58 | 67 | 28.83 | 29.96 | ..... | 75.9 | +4.5 | 100 | 24 | 90 | 50 | 31 | 62 | 37 | 58 | 45 | 39 | T | −.3 | 0 | 7.7 | nw. | 20 | nw. | 18 | 25 | 6 | 0 | 1.4 | .0 | .0 |
| ***North Pacific Coast Region*** | | | | | | | **64.8** | **+1.4** | | | | | | | | | | **71** | **0.39** | **−0.4** | | | | | | | | | **4.3** | | |
| North Head | 211 | 11 | 56 | 29.91 | 30.14 | +.06 | 57.4 | +.2 | 65 | 18 | 61 | 52 | 16 | 54 | 10 | 55 | 54 | 90 | .14 | −.8 | 5 | 15.5 | nw. | 34 | nw. | 7 | 10 | 8 | 13 | 5.9 | .0 | .0 |
| Seattle | 125 | 90 | 321 | 29.95 | 30.08 | +.04 | 65.8 | +2.7 | 89 | 24 | 75 | 53 | 2 | 56 | 32 | 58 | 52 | 65 | .69 | +.1 | 6 | 7.5 | ne. | 21 | s. | 28 | 14 | 11 | 6 | 4.1 | .0 | .0 |
| Tatoosh Island | 86 | 10 | 54 | 30.03 | 30.13 | +.08 | 55.4 | +.3 | 64 | 19 | 58 | 48 | 31 | 52 | 13 | 53 | 52 | 91 | .42 | −1.1 | 6 | 9.1 | sw. | 28 | s. | 27 | 5 | 9 | 17 | 7.3 | .0 | .0 |
| Medford [1] | 1,329 | 29 | 58 | 28.59 | 29.97 | ..... | 72.6 | +1.6 | 99 | 23 | 89 | 46 | 6 | 56 | 43 | 59 | 51 | 56 | .30 | −.1 | 2 | ..... | w. | ..... | ..... | ..... | 24 | 7 | 0 | 1.6 | .0 | .0 |
| Portland, Oreg | 153 | 68 | 106 | 29.90 | 30.06 | +.01 | 68.4 | +1.7 | 89 | 24 | 78 | 50 | 31 | 58 | 27 | 60 | 54 | 64 | .20 | −.4 | 3 | 6.6 | nw. | 17 | nw. | 10 | 15 | 10 | 6 | 4.0 | .0 | .0 |
| Roseburg | 510 | 45 | 76 | 29.50 | 30.04 | +.01 | 69.2 | +1.8 | 94 | 25 | 83 | 47 | 31 | 56 | 36 | 59 | 52 | 61 | .07 | −.2 | 2 | 5.7 | n. | 18 | n. | 6 | 18 | 11 | 2 | 2.8 | .0 | .0 |
| ***Middle Pacific Coast Region*** | | | | | | | **69.2** | **+1.9** | | | | | | | | | | **61** | **0.01** | **0.0** | | | | | | | | | **3.1** | | |
| Eureka | 62 | 73 | 89 | 29.97 | 30.04 | −.01 | 55.8 | +.3 | 63 | 12 | 60 | 48 | 6 | 52 | 14 | 53 | 51 | 84 | .03 | −.1 | 2 | 7.3 | nw. | 24 | n. | 5 | 8 | 14 | 9 | 5.2 | .0 | .0 |
| Redding [1] | 722 | 20 | 34 | ..... | ..... | ..... | 84.7 | +2.9 | 107 | 9 | 98 | 60 | 18 | 72 | 33 | 62 | 45 | 29 | T | −.1 | 0 | 8.6 | nw. | 26 | nw. | 4 | 26 | 4 | 1 | 1.3 | .0 | .0 |
| Sacramento | 66 | 92 | 115 | 29.78 | 29.86 | −.02 | 76.8 | +3.6 | 107 | 3 | 93 | 53 | 16 | 60 | 40 | 61 | 50 | 48 | T | .0 | 0 | 7.9 | s. | 18 | s. | 30 | 29 | 2 | 0 | .6 | .0 | .0 |
| San Francisco | 155 | 112 | 132 | 29.76 | 29.93 | −.02 | 59.3 | +.8 | 77 | 20 | 64 | 51 | 5 | 54 | 23 | 55 | 53 | 84 | T | .0 | 0 | 11.1 | w. | 25 | w. | 3 | 10 | 11 | 10 | 8.2 | .0 | .0 |
| ***South Pacific Coast Region*** | | | | | | | **74.4** | **+1.2** | | | | | | | | | | **63** | **0.05** | **0.0** | | | | | | | | | **3.5** | | |
| Fresno | 327 | 97 | 105 | 29.50 | 29.84 | +.01 | 83.4 | +1.3 | 108 | 3 | 98 | 58 | 18 | 68 | 38 | 63 | 48 | 35 | T | .0 | 0 | 6.9 | nw. | 18 | nw. | 27 | 23 | 5 | 3 | 2.1 | .0 | .0 |
| Los Angeles | 338 | 159 | 191 | 29.55 | 29.91 | +.01 | 71.4 | +1.2 | 94 | 1 | 80 | 58 | 9 | 62 | 27 | 63 | 60 | 74 | .00 | .0 | 0 | 5.6 | sw. | 14 | w. | 25 | 20 | 10 | 1 | 3.1 | .0 | .0 |
| San Diego | 87 | 62 | 70 | 29.81 | 29.90 | −.02 | 68.4 | +1.2 | 85 | 1 | 73 | 61 | 8 | 64 | 20 | 63 | 61 | 81 | .16 | +.1 | 2 | 7.0 | w. | 16 | w. | 13 | 11 | 12 | 8 | 5.3 | .0 | .0 |
| ***West Indies*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| San Juan, P. R | 82 | 9 | 54 | 29.94 | 30.03 | ..... | 80.6 | +.5 | 90 | 14 | 85 | 72 | 17 | 76 | 13 | ..... | ..... | ..... | 5.76 | −.2 | 16 | 13.0 | e. | 34 | e. | 18 | 9 | 16 | 6 | 4.7 | .0 | .0 |
| ***Panama Canal*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balboa Heights | 118 | 6 | 92 | ..... | [2]29.82 | .00 | 80.8 | +.5 | 92 | 28 | 87 | 72 | 31 | 74 | 16 | ..... | ..... | [2]85 | 6.57 | −.7 | 20 | 5.2 | nw. | 20 | nw. | 20 | 0 | 19 | 12 | 7.0 | .0 | .0 |
| Cristobal | 36 | 6 | 97 | ..... | [2]29.84 | .00 | 82.0 | +1.6 | 89 | 19 | 87 | 74 | 21 | 77 | 14 | 77 | 76 | [2]84 | 9.50 | −6.1 | 25 | 7.7 | n. | 23 | n. | 19 | 0 | 8 | 23 | 8.3 | .0 | .0 |
| ***Alaska*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fairbanks | 454 | 11 | 87 | [2]29.34 | [2]29.84 | ..... | 60.3 | +.3 | 84 | 13 | 73 | 41 | 28 | 48 | 36 | 52 | 44 | 62 | 1.32 | −.6 | 14 | 6.1 | ne. | 30 | sw. | 2 | 7 | 12 | 12 | 6.5 | .0 | .0 |
| Juneau | 80 | 96 | 116 | [2]29.96 | [2]30.05 | ..... | 55.1 | −2.0 | 72 | 3 | 60 | 44 | 2 | 50 | 27 | 51 | 48 | 79 | 8.15 | +3.0 | 23 | 6.2 | s. | 20 | e. | 27 | 0 | 4 | 27 | 9.2 | .0 | .0 |
| Nome | 22 | 5 | 32 | [2]29.81 | [2]29.83 | ..... | 53.0 | +3.0 | 72 | 14 | 60 | 33 | 8 | 45 | 28 | 50 | 47 | 80 | .90 | −1.9 | 8 | 7.4 | sw. | 24 | e. | 30 | 5 | 10 | 16 | 6.9 | .0 | .0 |
| ***Hawaiian Islands*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Honolulu | 38 | 86 | 100 | [2]29.98 | [2]30.02 | ..... | 77.4 | −.3 | 84 | 26 | 82 | 70 | 28 | 73 | 11 | 70 | 66 | 70 | 1.51 | +.3 | 20 | 10.7 | e. | 28 | e. | 31 | 12 | 17 | 2 | 4.2 | .0 | .0 |

[1] Observations taken at airport. [2] Observations taken bihourly. [3] Pressure not reduced to a mean of 24 hours.

LATE REPORTS FOR JUNE 1937

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenville, Maine | 1,070 | 6 | 40 | 28.77 | 29.92 | ..... | 60.2 | ..... | 86 | 1 | 70 | 39 | 16 | 50 | 31 | 56 | 54 | ..... | 5.04 | ..... | 15 | 3.7 | n. | 18 | ..... | 9 | 5 | 4 | 21 | ..... | 0.0 | 0.0 |
| Hatteras, N. C | 11 | 5 | 50 | 29.94 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 4.5 | ..... | ..... |

TABLE 3.—*Data furnished by the Canadian Meteorological Service, July 1937*

| Stations | Altitude above mean sea level, Jan. 1, 1919 | Pressure | | | Temperature of the air | | | | | | Precipitation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station reduced to mean of 24 hours | Sea level reduced to mean of 24 hours | Departure from normal | Mean max. + mean min. ÷2 | Departure from normal | Mean maximum | Mean minimum | Highest | Lowest | Total | Departure from normal | Total snowfall |
| | *Feet* | *In.* | *In.* | *In.* | *°F.* | *°F.* | *°F.* | *°F.* | *°F.* | *°F.* | *In.* | *In.* | *In.* |
| Cape Race, Newfoundland | 99 | 29.86 | 29.96 | −0.03 | 56.1 | +0.9 | 63.0 | 49.2 | 73 | 42 | 3.47 | −0.18 | 0.0 |
| Sydney, Cape Breton Island | 48 | 29.86 | 29.92 | −.02 | 67.4 | +3.5 | 79.0 | 55.9 | 92 | 43 | .34 | −3.10 | .0 |
| Halifax, Nova Scotia | 88 | 29.70 | 29.96 | .00 | 67.6 | +2.8 | 76.1 | 59.1 | 87 | 54 | 1.44 | −2.40 | .0 |
| Yarmouth, Nova Scotia | 65 | 29.87 | 29.98 | +.02 | 63.2 | +2.5 | 71.8 | 54.6 | 84 | 48 | 3.68 | +.22 | .0 |
| Charlottetown, Prince Edward Island | 38 | 29.86 | 29.94 | +.02 | 68.2 | +3.1 | 77.2 | 59.3 | 86 | 52 | .79 | −2.25 | .0 |
| Chatham, New Brunswick | 28 | 29.80 | 29.90 | .00 | 68.7 | +2.3 | 79.9 | 57.5 | 91 | 45 | 2.13 | −1.90 | .0 |
| Father Point, Quebec | 20 | 29.84 | 29.86 | .00 | 60.0 | +2.2 | 68.0 | 52.1 | 76 | 46 | 2.44 | −.74 | .0 |
| Quebec, Quebec | 296 | 29.60 | 29.92 | +.02 | 70.1 | +3.4 | 78.7 | 61.5 | 89 | 55 | 4.38 | +.18 | .0 |
| Doucet, Quebec | 1,236 | 29.61 | 29.94 | +.01 | 62.3 | +3.8 | 75.9 | 48.6 | 92 | 33 | 2.85 | −2.18 | .0 |
| Montreal, Quebec | 187 | 29.74 | 29.94 | +.03 | 72.0 | +2.5 | 79.9 | 64.1 | 89 | 56 | 5.05 | +1.35 | .0 |
| Ottawa, Ontario | 236 | 29.66 | 29.90 | −.02 | 69.6 | +.8 | 80.7 | 58.5 | 93 | 49 | 4.02 | +.63 | .0 |
| Kingston, Ontario | 285 | 29.62 | 29.94 | .00 | 70.5 | +2.1 | 77.7 | 63.3 | 86 | 54 | 1.35 | −1.60 | .0 |
| Toronto, Ontario | 379 | 29.54 | 29.95 | −.01 | 71.4 | +2.1 | 80.6 | 62.2 | 95 | 47 | 2.92 | +.04 | .0 |
| Cochrane, Ontario | 930 | 28.92 | 29.92 | +.02 | 62.4 | −.2 | 72.7 | 52.0 | 88 | 39 | 6.73 | +3.31 | .0 |
| White River, Ontario | 1,244 | 28.64 | 29.96 | +.04 | 61.9 | +1.3 | 75.2 | 48.5 | 93 | 30 | 7.44 | +4.33 | .0 |
| London, Ontario | 808 | 29.10 | 29.96 | −.02 | 69.4 | +.2 | 79.9 | 58.9 | 91 | 43 | 2.72 | −.34 | .0 |
| Southampton, Ontario | 656 | 29.25 | 29.95 | −.03 | 66.7 | +1.2 | 76.2 | 57.2 | 88 | 44 | .77 | −1.61 | .0 |
| Parry Sound, Ontario | 688 | 29.27 | 29.96 | +.02 | 69.2 | +2.2 | 79.3 | 59.1 | 90 | 46 | 3.33 | +.66 | .0 |
| Port Arthur, Ontario | 644 | 29.26 | 29.97 | +.04 | 62.4 | −.5 | 72.6 | 52.2 | 88 | 41 | 5.31 | +1.80 | .0 |
| Winnipeg, Manitoba | 760 | 29.10 | 29.91 | −.02 | 69.6 | +2.9 | 80.9 | 58.3 | 92 | 45 | 2.83 | −.24 | .0 |
| Minnedosa, Manitoba | 1,690 | 28.16 | 29.94 | +.04 | 66.7 | +3.0 | 79.7 | 53.7 | 96 | 41 | 1.55 | −.94 | .0 |
| Le Pas, Manitoba | 860 | 28.94 | 29.90 | +.01 | 68.2 | +3.9 | 81.9 | 55.6 | 96 | 46 | .57 | −1.75 | .0 |
| Qu'Appelle, Saskatchewan | 2,115 | 27.68 | 29.91 | −.01 | 69.8 | +5.8 | 84.1 | 55.6 | 107 | 44 | 1.07 | −1.60 | .0 |
| Moose Jaw, Saskatchewan | 1,759 | 27.96 | 29.91 | +.05 | 72.3 | +6.7 | 85.4 | 59.2 | 110 | 47 | 2.82 | +.70 | .0 |
| Swift Current, Saskatchewan | 2,392 | 27.40 | 29.90 | .00 | 71.1 | +5.4 | 85.9 | 56.3 | 104 | 42 | .98 | −1.38 | .0 |
| Medicine Hat, Alberta | 2,365 | 27.46 | 29.89 | +.01 | 72.2 | +3.0 | 85.5 | 58.6 | 105 | 50 | .96 | −.84 | .0 |
| Calgary, Alberta | 3,540 | | | | | | | | | | | | |
| Banff, Alberta | 4,521 | | | | | | | | | | | | |
| Prince Albert, Saskatchewan | 1,450 | 28.40 | 29.92 | +.01 | 69.2 | +6.2 | 81.2 | 57.2 | 98 | 48 | 1.46 | −.81 | .0 |
| Battleford, Saskatchewan | 1,592 | 28.21 | 29.91 | .00 | 67.6 | +4.2 | 82.2 | 53.0 | 102 | 44 | 4.07 | +1.87 | .0 |
| Edmonton, Alberta | 2,150 | 27.68 | 29.94 | +.06 | 63.2 | +1.8 | 73.7 | 52.7 | 86 | 46 | 8.31 | +5.03 | .0 |
| Kamloops, British Columbia | 1,262 | 28.68 | 30.00 | +.06 | 72.2 | +2.4 | 85.4 | 58.9 | 100 | 50 | .78 | −.24 | .0 |
| Victoria, British Columbia | 230 | 29.82 | 30.06 | +.02 | 60.1 | +.2 | 67.9 | 52.3 | 73 | 50 | .01 | −.40 | .0 |
| Barkerville, British Columbia | 4,180 | | | | | | | | | | | | |
| Estevan Point, British Columbia | 20 | | | | | | | | | | | | |
| Prince Rupert, British Columbia | 170 | 29.92 | 30.10 | +.02 | 56.8 | +.8 | 64.5 | 49.1 | 75 | 42 | 4.25 | −.62 | .0 |
| St. George's, Bermuda | 158 | | 30.17 | +.03 | 81.4 | +2.9 | 87.0 | 75.8 | 92 | 73 | 1.61 | −2.17 | .0 |

LATE REPORTS FOR JUNE 1937

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montreal, Quebec | 187 | 29.70 | 29.90 | −0.01 | 66.4 | +1.7 | 74.5 | 58.2 | 84 | 52 | 4.30 | +.82 | 0.0 |
| Calgary, Alberta | 3,540 | 29.32 | 29.95 | +.07 | 57.4 | +1.5 | 68.8 | 46.0 | 94 | 36 | 3.22 | +.03 | .0 |
| Edmonton, Alberta | 2,150 | 27.63 | 29.89 | +.05 | 60.4 | +3.1 | 74.1 | 46.8 | 99 | 35 | .90 | −2.19 | .0 |

TABLE 4.—*Severe local storms, July 1937*

(Compiled by Mary O. Souder from reports submitted by Weather Bureau officials)

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

| Place | Date | Time | Width of path, yards | Loss of life | Value of property destroyed | Character of storm | Remarks |
|---|---|---|---|---|---|---|---|
| Pipestone, Rock, and Martin Counties, Minn. | 3 | 1–4 p. m. | | | $180,000 | Hail | Loss to growing crops, $175,000; property damage, $5,000. |
| Ackley to Aplington, Iowa, and vicinities. | 3 | 6 p. m. | | 0 | | Tornado | Buildings leveled; trees stripped and uprooted. |
| Mahaska, Wapello, and Davis Counties, Iowa. | 3 | 7–9 p. m. | 325 | 0 | 25,000 | Tornado and hail | Several buildings wrecked. Loss to crops, $20,000; property damage, $5,000. |
| Muscatine County, Iowa | 3 | 10 p. m. | | | 2,500 | Wind | Loss to wheat and oats. |
| Springfield, Mo. | 3 | | | | 5,000 | Thundersquall | Trees uprooted and outbuildings destroyed. Damage over a strip 2 blocks wide and 5 blocks long. |
| Fond du Lac and Dodge Counties, Wis. | 3 | | | | 25,000 | Hail | Windows broken; loss to crops, $25,000. |
| Swansea, S. C., vicinity of | 4 | 5 p. m. | | | 600 | Thunderstorm | Crop loss, $500; property damage, $100. |
| Fruitland, Idaho, vicinity of | 4 | 8 p. m. | 440 | 1 | 1,150 | Straight-line wind | Barn and several sheds demolished; some fruit trees blown down. |
| Charleston, Ill. | 4 | | | | 5,000 | Wind and hail | Loss to crops. |
| Tuscola, Ill. | 4 | | | | 50,000 | Hail | Do. |
| Burr Oak, Kans. | 5 | 3–4:30 p. m. | [1]3 | | 10,000 | do | Chief damage to wheat and oats; path 10 miles long. |
| Clay County, Kans. | 5 | 5 p. m. | [1]6 | | 5,000 | do | Loss mostly to crops; path 7 miles long. |
| Morris and Lyon Counties, Kans. | 5 | 5–5:30 p. m | | | 10,000 | do | Loss mostly to crops; damage to roofs and windows in Council Grove, $2,000. |
| Chester, S. C., 9 miles south | 5 | | 880 | | 2,000 | Thundersquall | Number of buildings unroofed; path 3 miles long. |
| Tallulah, La., vicinity of | 7 | 2–4 p. m. | | | 1,200 | Heavy hail | Much loss to crops. |
| Cleveland County, Iowa | 7 | 10 a. m. | 880 | | 1,500 | Hail | Loss to cotton and corn; path 4 miles long. |
| Edmunds County, S. Dak. | 8 | 6 p. m. | [1]1 | | 2,000 | Wind | 1 barn, several windmills, and chicken houses destroyed; 1 person injured. |
| Keokuk, Iowa, and vicinity | 8 | 6:30 p. m. | | | 20,000 | Thunderstorm and hail. | At Union station, a factory and many trees struck by lightning. |
| Grand Island, N. Y. | 10 | P. m. | | | 5,000 | Electrical | Barn damaged. |
| Wheeling, W. Va.,[2] and vicinity | 10 | do | | | | Wind and rain | More than 500 automobiles abandoned on Route 40, near Elm Grove, with from 4 to 6 feet of water on the highway. A tourist camp, 100 yards of Baltimore & Ohio Railway track, and 2 bridges washed out. |
| Wye Mills, Md. | 10 | | | | 2,500 | Electrical | Barn and contents destroyed. |
| Butte County, S. Dak. | 10 | | 880 | | 61,300 | Heavy rain and flood. | Between Belle Fourche, S. Dak., and Aladdin, Wyo., Hay Creek overflowed, flooding basements in Belle Fourche. Irrigation works damaged and crops washed out. |
| Oakland, Nebr. | 11 | 3–4 p. m. | [1]2 | | 36,000 | Heavy hail | No details. |
| Dillon County, S. C. | 11 | P. m. | 880 | | 5,000 | Wind | Loss to tobacco crop; path 10 miles long. |
| Durand,[2] Mich. | 11 | do | | | | Thundersquall and hail. | Hotel unroofed, trees uprooted, and many windows broken. |
| Ninety Six and Coronaco Creek, S. C. | 11 | do | | | 2,000 | do | Trees uprooted; several houses unroofed; crop loss because of hail, $1,000. |
| Sweetwater County, Wyo. | 11–12 | | | | 100,000 | Heavy rain and flood. | 2,000 persons temporarily homeless, being forced to leave 500 homes; much damage to highway, railway, and mine property. Railway service suspended for 24 hours, more than 3,000 feet of track being washed out and much covered by landslides. |
| Nelson County, Va. | 12 | 3 p. m. | [1]1 | | 8,000 | Hail | Loss mostly to corn and fruit. |
| Sula, Mont., vicinity of | 12 | 5–6 p. m. | 1,320 | | 1,000 | do | Property damaged. |
| Zell, S. Dak., vicinity of | 12 | 7:45 p. m. | 880 | 0 | 1,000 | Tornado | Do. |
| Shannon and Washington Counties, S. Dak. | 12 | | | 2 | 60,000 | Flood | Heavy rains caused Wounded Knee and White Clay Creeks to overflow, damaging highways, bridges, dams, and reservoirs. |
| Arkansas City, Kans., vicinity of. | 13 | 4:30 p. m. | | | 800 | Wind | No details. |
| Davidson, Okla. | 13 | 5 p. m. | [1]2 | | 2,000 | do | Principal damage to plate-glass windows and roofs; path 10 miles long. |
| Guthrie, Okla. | 13 | P. m. | [1]5 | | 3,500 | do | Damage principally to buildings; path 12 miles long. |
| Monmouth, Ill. | 13 | | | | 4,000 | do | Property damaged. |
| Pondera County, Mont. | 13 | | | | 35,000 | Heavy rain and flood. | Fences, gardens, shelterbelts, and crops destroyed. Path about 30 miles long and varied in spotted areas to at least 4 miles wide. |
| Cassia County, Idaho, north portion. | 14 | 11:45 a. m.–noon. | 880 | | 500 | Hail | Loss to crops; path 5 miles long. |
| Power County, Idaho, south portion. | 14 | Noon–1 p. m. | [1]1 | | 5,500 | Heavy hail | Loss to wheat; path 3 miles long. |
| Hancock County, Iowa | 14 | 5:30 p. m. | | | 10,000 | Wind | Corn and oat crops flattened. |
| Baltimore, Md., southeast portion. | 14 | 7 p. m. | | | 10,000 | Thundersquall | Houses unroofed and damaged; several chimneys blown down; wires broken; more than 40 trees uprooted. |
| Burden and Winfield, Kans., and vicinity. | 14 | P. m. | | | | Wind and rain | Many buildings unroofed; barn blown down; loss to growing crops. |
| Lake of the Woods, Pennington, Roseau, Beltrami, Marshall, Red Lake, and Clearwater Counties, Minn. | 14–16 | | | | 2,000,000 | Rain and flood | Many fields inundated; growing crops, culverts, and bridges washed out; highways damaged and basements flooded. Farm buildings in some districts more than half submerged. |
| Columbia, S. C. | 15 | 5:30 p. m. | | | 500 | Thundersquall | Section of a building roof at the fair grounds blown off. |
| Rice County, Kans. | 15 | 4 p. m. | 880 | 0 | 5,000 | Tornado | Damage to farm buildings and to fields of corn; path 15 miles long. |
| Reno County, Kans. | 15 | 4:30–5 p. m. | [1]1 | | 1,500 | Wind and hail | Chickens killed; loss to corn and other crops; path from 3 to 4 miles long. |
| Big Horn, Custer, and Rosebud Counties, Mont. | 15 | 4–7 p. m. | [1]1 | | | Hail | Considerable damage in Niles City to gardens. |
| Brown County, S. Dak. | 15 | 5:30–6 p. m. | 2,640 | | 42,400 | Wind and hail | Loss to crops; farm buildings destroyed. |
| Jefferson County, Kans. | 15 | 6 p. m. | [1]2½ | | 66,000 | Heavy hail | Loss chiefly to corn in a strip between Valley Falls and Oskaloosa; path 1 miles long. |
| Louisa County, Iowa | 15 | 7:30 p. m. | | | 600 | Wind | Property damaged. |
| Monroe, Mich. | 15 | 7:30–8 p. m. | | | 100,000 | do | 150 men of the public utilities worked all night to restore electric and phone service; theater unroofed and scenery thereof blown into the street. |
| Beardsley, Minn., and vicinity | 15 | 7:45 p. m. | [1]2½ | | 5,100 | Hail | Loss to growing crops, $5,000; property damage, $100; path 8 miles long. |
| Burchard, Nebr., and vicinity | 15 | 11:30–12 p. m. | [1]2 | | 52,000 | Wind and hail | Loss principally to crops; some old buildings damaged and windows broken. |
| Williston, S. C., vicinity of | 15 | P. m. | | | 1,500 | Thundersquall | Trees uprooted; several buildings unroofed; church blown over. |
| Mount Vernon, Ill. | 15 | | | | 5,000 | Wind | Property damaged. |
| Rockingham County, Va. | 16 | 3–3:30 p. m. | 880 | | 5,500 | Thundersquall and hail. | Do. |
| Webster County, Nebr. | 16 | 5 p. m. | [1]2 | | 20,000 | Hail | Do. |
| Gem, Kans., vicinity of | 16 | 6 p. m. | [1]2 | | 10,000 | do | Loss to crops; path 6 miles long. |
| Marshall and Washington Counties, Kans. | 16 | 6–6:30 p. m. | [1]4–10 | | 55,000 | Wind and hail | Loss to more than 4,000 acres of corn; barns wrecked; farming implements and power lines damaged; path 45 miles long. |
| Kearney County, Kans. | 16 | 8:30 p. m. | [1]15 | | 75,000 | Hail | No details. |
| Osage and Franklin Counties, Kans. | 16 | 9:55 p. m.–midnight. | [1]10 | | 50,000 | Wind | Many farm buildings damaged; path 25 miles long. |
| Sorento, Ill. | 16 | | | | 1,000 | Hail | Loss to crops. |
| Harrisburg, Pa. | 16 | | | | 5,000 | Electrical | Property damaged. |
| North, S. C. | 17 | 2 p. m. | | | 1,000 | do | Residence destroyed. |
| Vermont, central and south portions. | 17 | P. m. | | | | Wind, rain, electrical. | Gardens and shrubbery damaged; telephone and electric service disrupted in many sections; barn destroyed and the farmhouse damaged by lightning. |

[1] Miles of instead of yards.

[2] From press reports.

TABLE 4.—*Severe local storms, July 1937*—Continued

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

| Place | Date | Time | Width of path, yards | Loss of life | Value of property destroyed | Character of storm | Remarks |
|---|---|---|---|---|---|---|---|
| Ravenna, Nebr., vicinity of | 17 | | [1] 2 | | $60,000 | Hail | Property damaged. |
| Syracuse and Onondaga Counties, N. Y. | 17 | | | | | Wind | Many trees blown across highways; wire service crippled; picnic tent blown down; several persons injured. |
| Culpeper and Fauquier Counties, Va.[2] | 17 | | | | | Wind and rain | Houses unroofed; steeple torn from a church; many trees struck by lightning. |
| Dallas and Madison Counties, Iowa. | 18 | 2-4 p. m. | [1] 5 | | 50,000 | Wind and hail | Hail completely destroyed some crops and wind flattened others. |
| Franklin, Nebr. | 18 | 5:30-6 p. m | 1,320 | | 10,000 | Hail | No details. |
| Lincoln, Nebr. | 18 | 6 p. m. | | | | Wind and rain | Light and telephone service disrupted; roof of a store blown off and the merchandise damaged. One person injured. |
| Montgomery County, Iowa | 18 | 7:30 p. m. | [1] 2 | | 10,000 | Wind and hail | Loss to crops. |
| Fredonia, Kans.,[2] and vicinity | 18 | 11 p. m. | | | | Wind and rain | Extensive property damage; trees broken and uprooted; wires down. |
| Barnwell County, S. C. | 18 | P. m. | | | 4,000 | Rain | Roads damaged and bridges washed out. |
| Page County, Iowa | 18 | | | | 5,000 | Wind and hail | Crop loss, $3,000; buildings damaged, $2,000. |
| Woodside, Md. | 18 | | | | 500 | Electrical | House damaged; 2 men stunned. |
| Omaha, Nebr. | 18 | | | | 40,000 | Rain | Streets, sewers, and basements flooded; pavements washed out. |
| Douglas and Bisbee, Ariz. | 19 | | | | 5,500 | Wind and rain | Property damaged. |
| Pueblo, Colo. | 19 | | | | | Hail | Automobile tops riddled and windows broken in some sections of the city. |
| Elizabethtown, Black Lake, Sapello, Las Vegas, Tecolore, and Chapelle, N. Mex., and vicinities. | 20 | Noon-1 p. m. | [1] 10-15 | | 14,000 | do | Approximate area of the storm 1,000 square miles. |
| Charleston, S. C. | 20 | 3 p. m. | | | 500 | Tornadic winds | Damage to roofs, awnings, windows, and automobiles. |
| Marietta, Okla. | 20 | 5 p. m. | 1,320 | | 12,500 | Wind | Crop loss, $7,500; property damage, $5,000. |
| River Falls, Wis., vicinity of | 21 | | | | 5,000 | Hail | Loss to corn and small grain. |
| Watonwan, Swift, and Stearns Counties, Minn. | 22 | 3-6 p. m. | | | 60,000 | do | Severe damage to growing crops; some loss to property. |
| Douglas County, Kans. | 23 | 5:15-5:45 p. m. | [1] 5 | | 75,000 | Wind and hail | Chief damage to corn and truck crops; path 15 miles long. |
| Sturgeon Bay, Wis. | 23 | | | | 1,000 | Hail | Loss to cherry crop. |
| Groton, S. Dak., vicinity of | 24 | 3:30 p. m. | | | 5,000 | Wind and rain | Buildings wrecked; farm machinery destroyed. |
| Hartington, Nebr., vicinity of | 24 | 7 p. m. | [1] 3 | | 25,000 | Heavy hail | Property damaged. |
| Plymouth County, Iowa | 24 | 8-10 p. m. | [1] 5 | | 200,000 | Hail and wind | Principal damage from hail, in some sections causing complete loss to crops; windows broken. |
| Albion, N. Y. | 24 | | | | 10,000 | Electrical | 2 barns and contents burned. |
| Beresford, S. Dak.[2] | 24 | | [1] 3 | | 10,000 | Rain and hail | This storm one of the most severe in this section. Many plate glass windows broken; city without street lights; automobile tops broken. More than an inch of rain recorded. |
| Philadelphia, Ind., vicinity of | 25 | 1 p. m. | | 0 | | Tornado | Large barn demolished, 2 others, only 200 feet away, untouched; trees uprooted. |
| Grangeville, Idaho | 25 | 2 p. m. | [1] 7½ | | 110,000 | Hail | Heavy crop damage over considerable area; property damage negligible; path 8 miles long. |
| Henriette, Tex., vicinity of | 25 | 4:30 p. m. | [1] 2 | | 7,000 | do | Loss to crops; path 10 miles long. |
| Page, Nebr., vicinity of | 25 | 11 p. m. | [1] 1-3 | | 10,000 | Wind and hail | Property damaged. |
| Olney, Ill. | 25 | | | | 1,000 | Wind | Damage to property and shade trees. |
| Hart to Traverse City, Mich. | 25 | | | | | do | Heavy loss to cherry crop. |
| Door County, Wis. | 25 | | | | 20,000 | do | Loss to cherry crop. |
| Terryville and Bristol, Conn., and vicinity. | 26 | 3:45 p. m. | 150-200 | | 50,000 | Tornadic wind and rain. | Storm started south of Terryville at the western end of the Terryville railroad tunnel, passing over Pequabuck, finally disappearing a mile or so east of Bristol after visiting the northern section of that town. Over 1,200 shade and timber trees twisted and broken, others uprooted. Extensive damage to telephone and power equipment. Some loss to crops. Small buildings picked up and moved many feet, a new silo being carried more than 200 yards away. |
| Castleford, Idaho, vicinity of | 26 | 5 p. m. | 880 | | 10,000 | Heavy hail | Loss to crops; path 4 miles long. |
| Buffalo, N. Y., water front | 26 | | | | 20,000 | Wind | 35 or more small boats torn from their moorings and damaged or wrecked. |
| Rochester, N. Y., and vicinity | 26 | | | | | Thundersquall | 11 buildings struck by lightning and 8 burned. Many trees blown down; much damage to telephone and power lines. |
| Valentine, Nebr., vicinity of | 27 | 3:55 a. m. | | | 3,000 | Electrical | Lumber shed and contents burned. |
| Emmett, Idaho, vicinity of | 27 | 5 p. m. | 880-1,320 | | 5,000 | Hail | Loss to crops; path 2 to 3 miles long. |
| Washington, southeast portion of the State. | 27 | | | | 21,000 | Thundersquall and hail. | Loss to wheat from hail; property damaged by fire. |
| Phoenix, Ariz. | 27-28 | | | | 3,000 | Thunderstorm | Damage to electrical equipment. |
| Russell County, Kans., southwest portion. | 28 | | | | | Heavy hail and wind. | Reported to have been the worst storm locally since 1900; property damaged; barn blown away; gardens destroyed; trees damaged. |
| Belden to Carroll, Nebr. | 29 | 3:15-3:50 p. m. | [1] 3-10 | | 400,000 | Heavy hail | Corn down; crop totally destroyed over most of path. |
| Memphis, Tenn. | 29 | 3:38 p. m. | | 0 | 1,000 | Tornado | No details. |
| Dodge City, Kans., 2 miles north. | 29 | 5:35-5:50 p. m. | | 0 | | Tornadoes | 5 small tornadoes observed for short intervals. They occurred on the edge of a thunderstorm system that moved slowly from west to east. No damage reported. |
| Franklinville, Clarksburg, and Jamestown, N. Y., and vicinities. | 29 | P. m. | | | 13,500 | Electrical | Chief damage to barns by fire. |
| Tucson, Ariz., vicinity of | 29 | | | 1 | 800 | Thundersquall | Farmer killed when his house collapsed. |
| Waddington and West Potsdam, N. Y. | 30 | 2 a. m. | | | | Thunderstorm | Barns destroyed. |
| Pingree, Idaho | 30 | | | | 4,000 | Heavy hail | Loss to crops over an area 2 miles square. |
| Cayuga County, N. Y. | 30 | | 880 | | | do | Much loss to buckwheat, corn, and oats. |
| Carlisle, Pa., vicinity of | 30 | | | | 10,000 | Electrical | 4 barns destroyed. |
| Clarke County, Iowa | 31 | 11 a. m. | 440 | 0 | 4,000 | Tornado and rain. | Roofs blown off; trees down and basements flooded. Crop loss, $3,000; property damage, $1,000. |
| Cass County, Iowa | 31 | 12:30 p. m. | | | 7,500 | Rain and hail | Houses flooded. |
| Butte, Mont. | 31 | 2-3 p. m. | | | | do | Considerable damage to gardens and flowers; no loss to crops. |
| Jefferson County, Iowa | 31 | 6 p. m. | [1] 4 | | 10,000 | Wind and hail | Property damaged. |
| Pearl, Colo., vicinity of | 31 | | | | 1,000 | Electrical | Barn damaged. |

[1] Miles of instead of yards.

[2] From press reports.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, July 1937

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

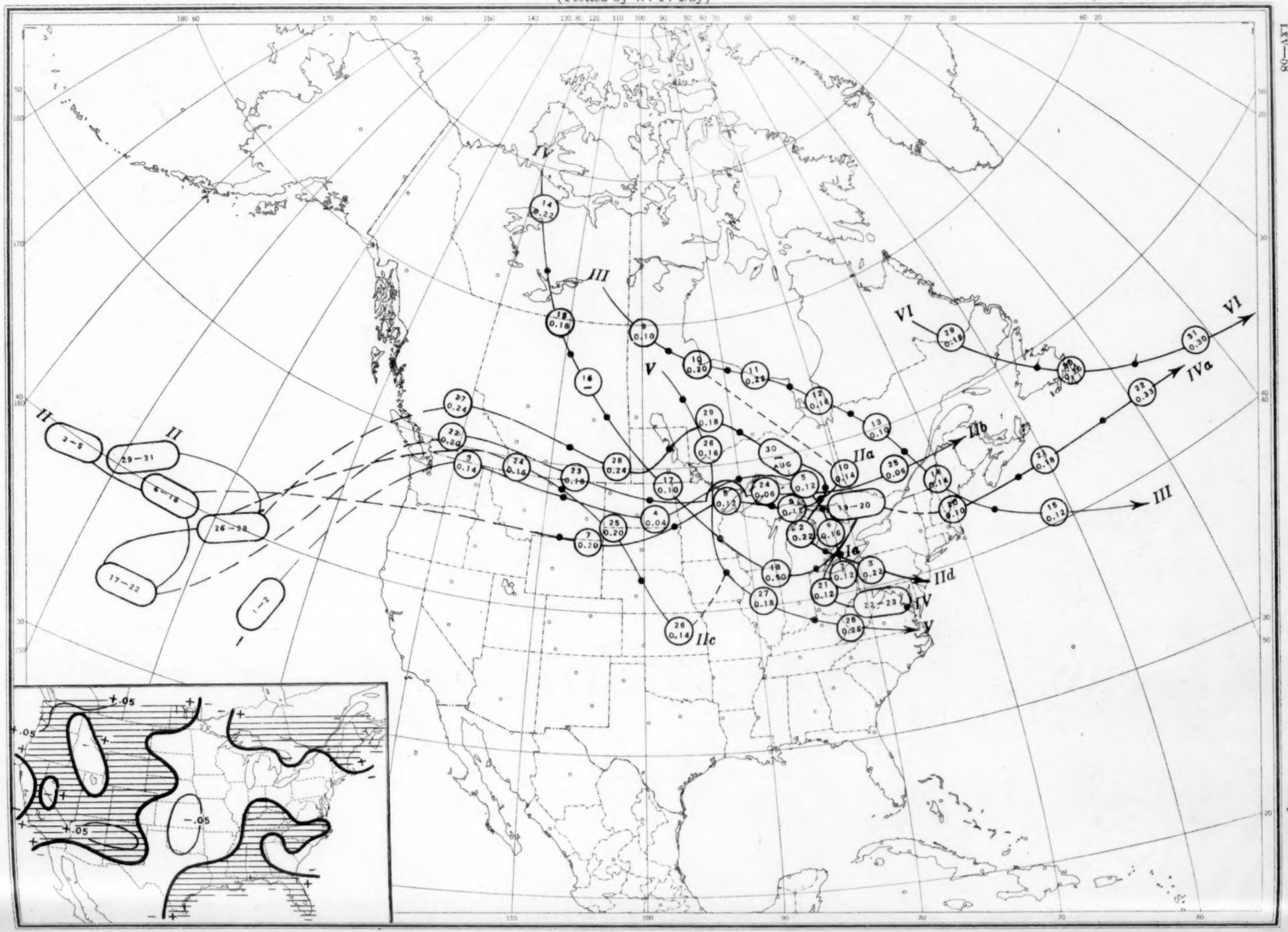
Chart I. Departure (°F.) of the Mean Temperature from the Normal, July 1937

**Chart I. Departure (°F.) of the Mean Temperature from the Normal, July 1937**

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

## Chart II. Tracks of Centers of Anticyclones, July 1937. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. P. Day)




Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

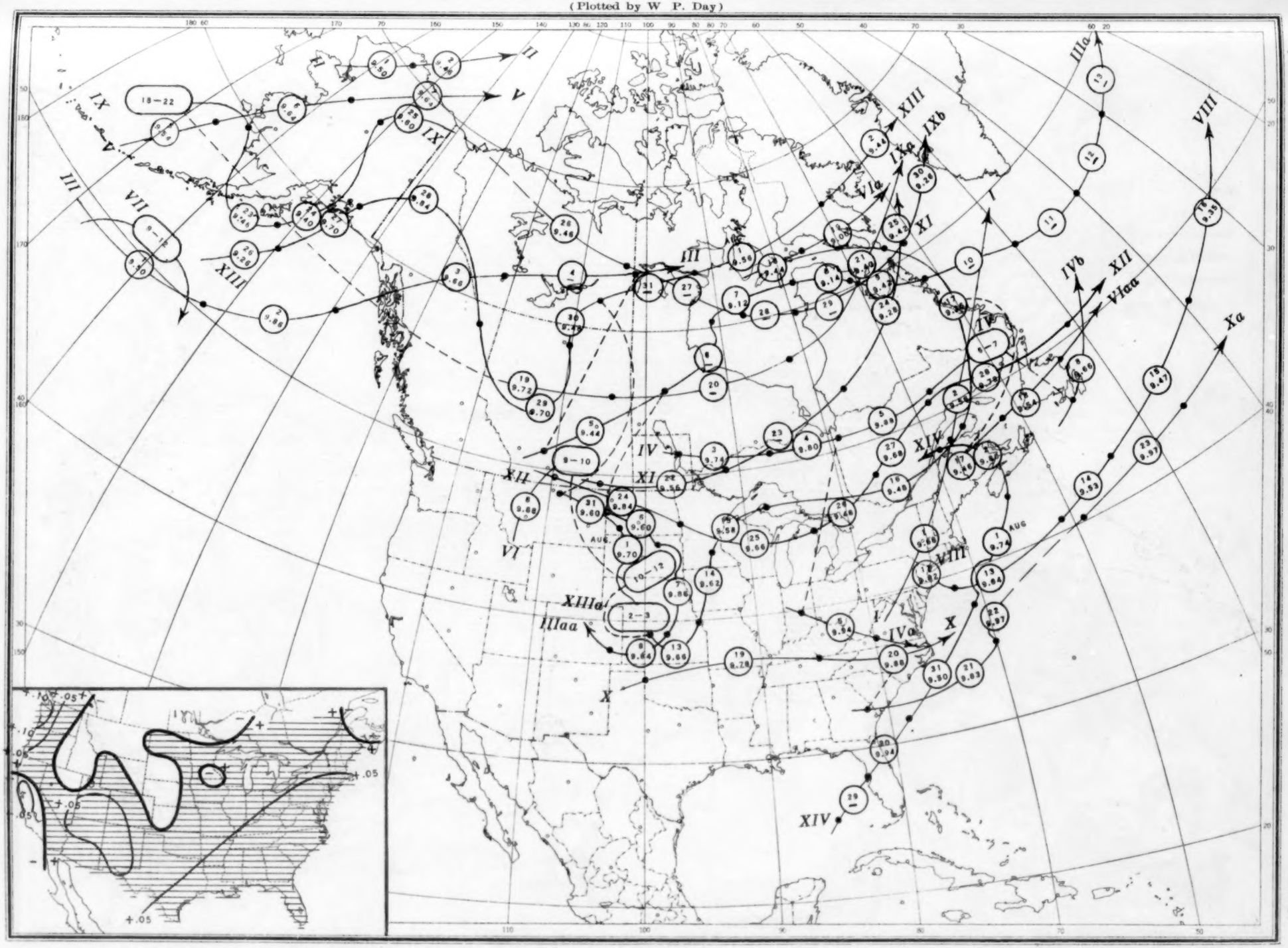
## Chart III. Tracks of Centers of Cyclones, July 1937. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)

Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

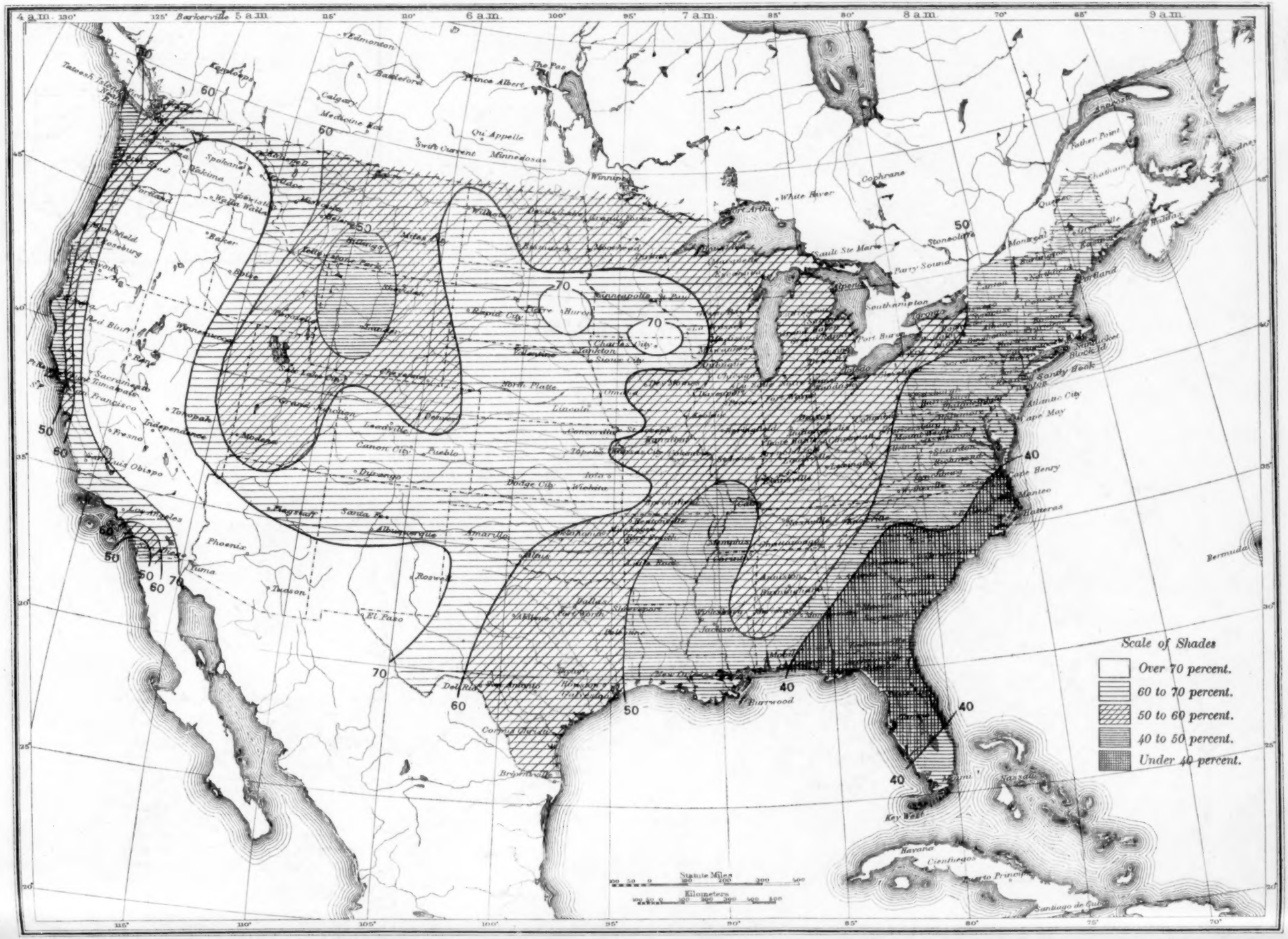
**Chart III. Tracks of Centers of Cyclones, July 1937. (Inset) Change in Mean Pressure from Preceding Month**

(Plotted by W P. Day)



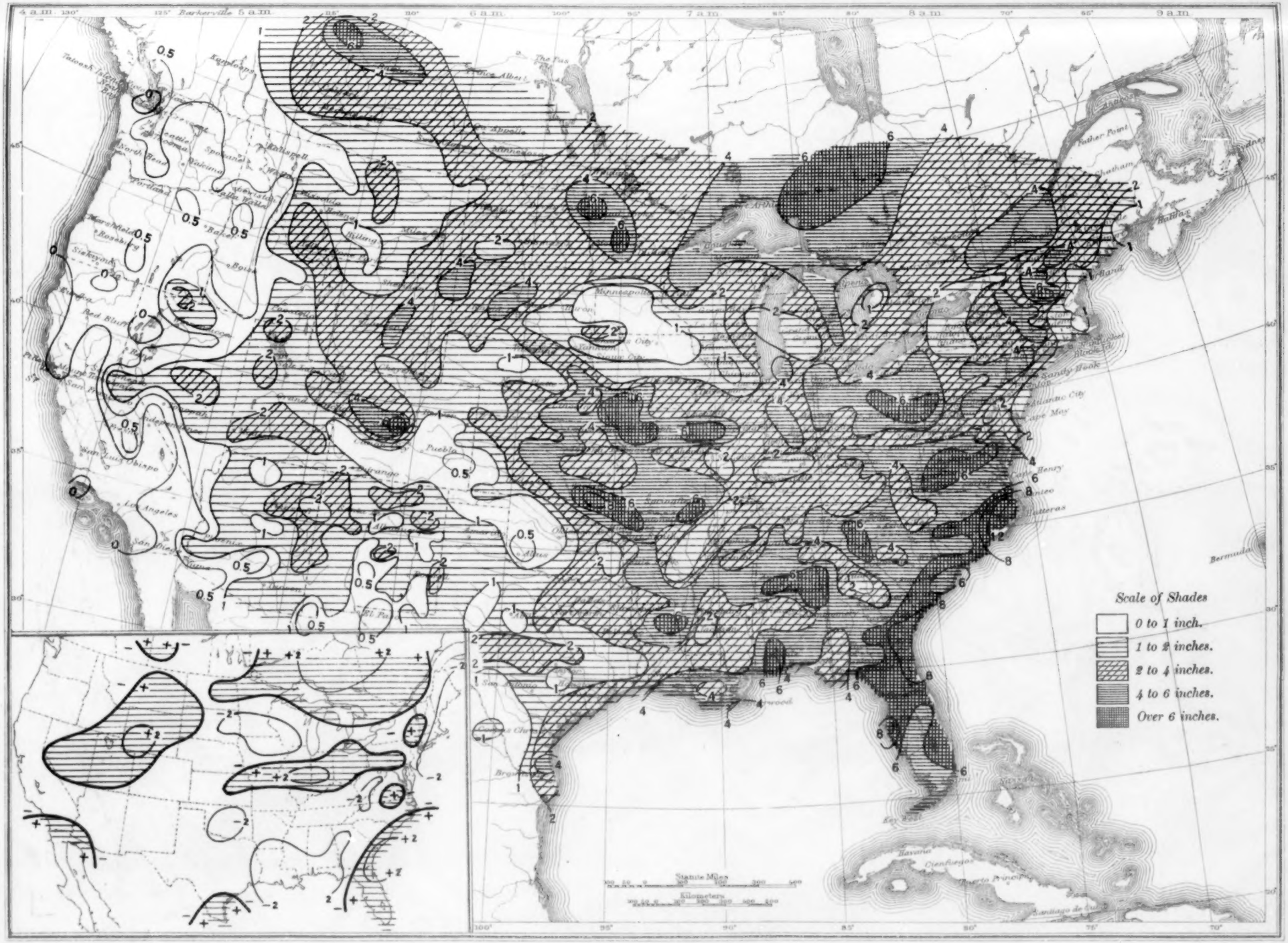

Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

## Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, July 1937

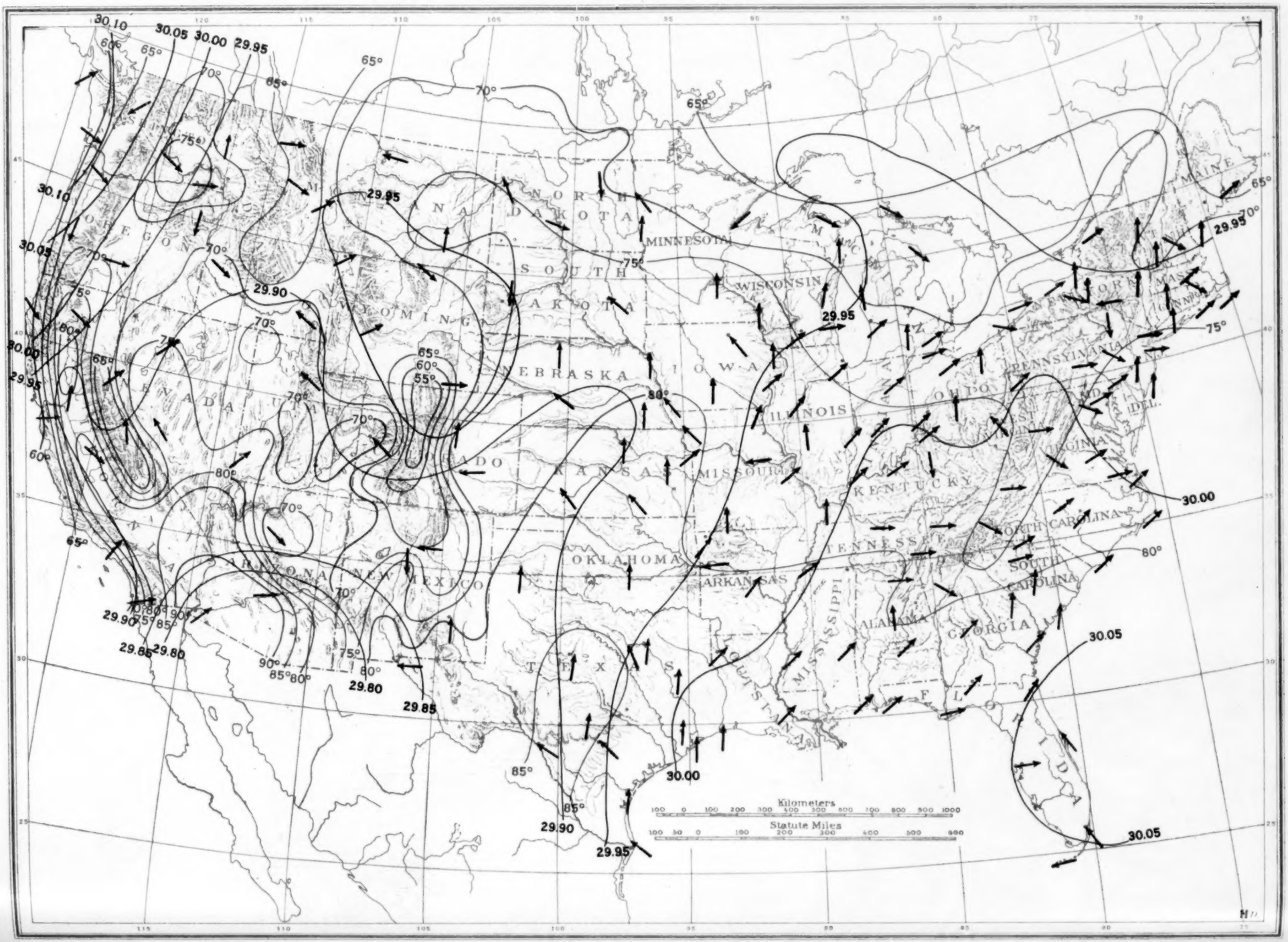



## Chart V. Total Precipitation, Inches, July 1937. (Inset) Departure of Precipitation from Normal

**Chart V.** Total Precipitation, Inches, July 1937. (Inset) Departure of Precipitation from Normal



## Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, July 1937






## Chart VII. Wind Roses for Selected Stations, July 1937

(Plotted by W. W. Reed)

# Chart VII. Wind Roses for Selected Stations, July 1937

(Plotted by W. W. Reed)

U.S. WEATHER BUREAU